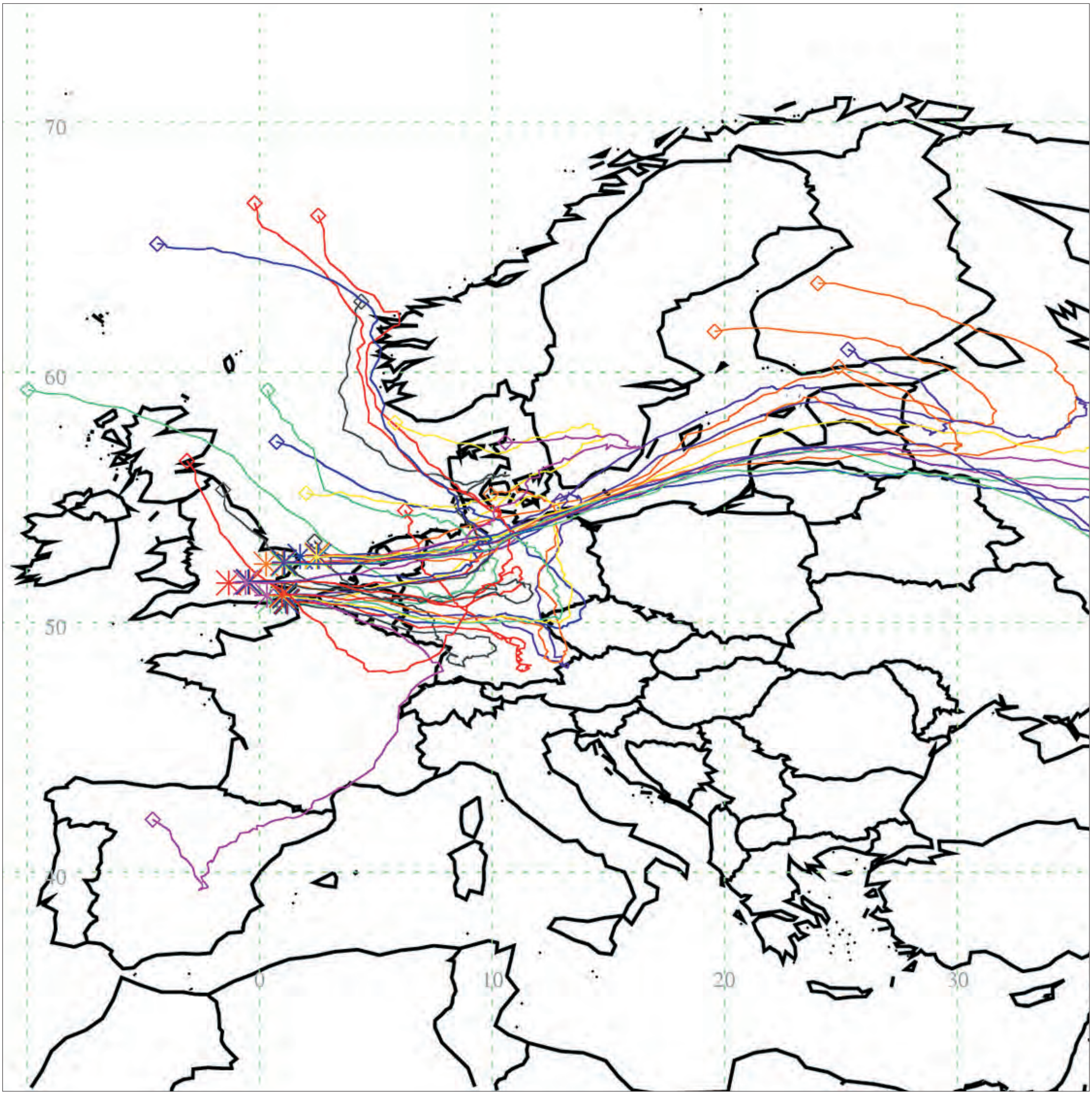
Chemical Hazards and Poisons Report

From the Chemical Hazards and Poisons Division
September 2008 Issue 13



Contents

Editorial

Editor: Professor Virginia Murray
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Chemical Hazards and Poisons Division (London)

As usual in this issue a number of significant incidents are presented. The story of Hampole quarry highlights the value of good environmental management in preventing a potentially very difficult chemical incident; issues related to tyre fires have been reported in a previous Chemical Hazards and Poisons Report. Yet again, odours are included in this issue: they are difficult to manage particularly when the source is difficult to identify, as the two incidents reported here highlight; odours across the South East of England and Wales, and the investigation of an odour incident in a residential care home

A number of articles related to emergency preparedness are included. Of note are two papers on carbon monoxide, one on public health surveillance and the other on the carbon monoxide toolkit. The article on mass psychogenic illness summarises the issues that arise in these kinds of incidents and provides some advice on how to manage them. A paper on the development of appropriate tools and generic scenarios for prioritising chemicals of concern and predicting the public health impact following a deliberate chemicals release is included, along with information about the Dapple field work experiments.

Environmental science issues are, as always, of significance, and in this issue, the focus is waste with a report on fly tipping, while another discusses how we assess different waste management strategies, using the North London Waste Authority as a case study.

This issue has a section on natural disasters and climate change. The International Strategy for Disaster Reduction and its Hyogo Framework for Action (2005-2015): Building the Resilience of Nations and Communities to Disasters is summarised. The volcanic eruption in Montserrat in 1995 is described, with a consideration of the public health issues generated by exposure to ash and from living close to the site of the volcano. An exciting opportunity to use space radars to detect small ground movements to assist in risks assessment and disaster reduction is presented. A paper on guidance on windstorms for the public health workforce is included.

A series of conference reports are included in this issue. They cover critical infrastructure and flooding, the Water Contamination Emergencies Conference – Collective Responsibility, 'Our Coast and Health Conference 2008' and the 4th UK and Ireland Meeting on Occupational and Environmental Epidemiology.

The next issue of the Chemical Hazards and Poisons Report is planned for January 2009. The deadline for submissions for this issue is 1st November 2008. Please do not hesitate to contact us about any papers you may wish to submit. Please contact us on chap.report@hpa.org.uk, or call us on 0207 759 2871.

We are very grateful to Professor Gary Coleman for his support in preparing this issue.

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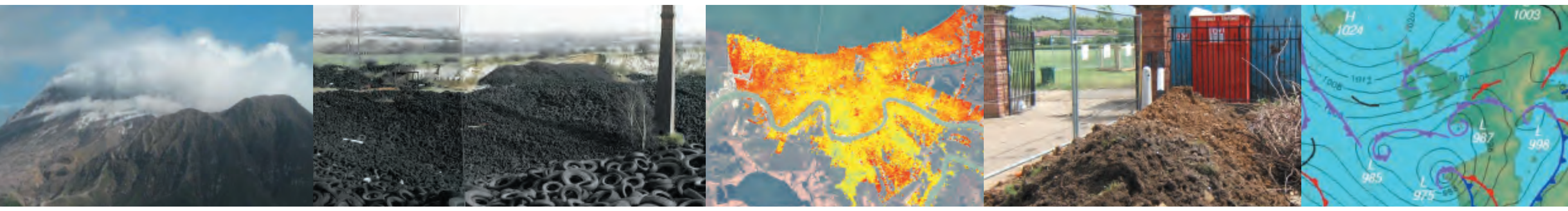

Incident Response

The Hampole Quarry

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3. Environment Agency

Introduction

Originally quarried for limestone, Hampole Quarry site is a three hectare disused limestone quarry and former railway cutting located adjacent to the A1(M) to the northwest of Doncaster in South Yorkshire. The site is situated in a rural area close to the small towns of Skellow and Adwick le Street. It is bounded by the A638 trunk road immediately to the south, and by agricultural land to the north, east and west. The A1/A1(M) is some 500 metres to the east and the London-Leeds (east coast mainline railway linking London to Leeds) railway is located 500 metres to the north. Three houses are situated some 30 metres west of the site.

Between the 1970s and 1990s, the site was subjected to the uncontrolled and illegal dumping of circa 23,000 tonnes of tyres equating to approximately three million tyres of various sizes, which made Hampole quarry the second largest tyre dump in the UK (figure 1). This stockpile of tyres created a visual eyesore to the local area but more significantly posed a major fire risk, which in turn could release toxic contaminants into the air and groundwater. It was on this basis that, in February 2003, Doncaster Metropolitan Borough Council formally determined the site as Contaminated Land and designated it a 'Special Site' under Part 2A of the Environmental Protection Act 1990, based on the 'significant possibility of significant harm' of toxic emissions to air and groundwater from burning tyres. The following significant pollution linkages were identified:

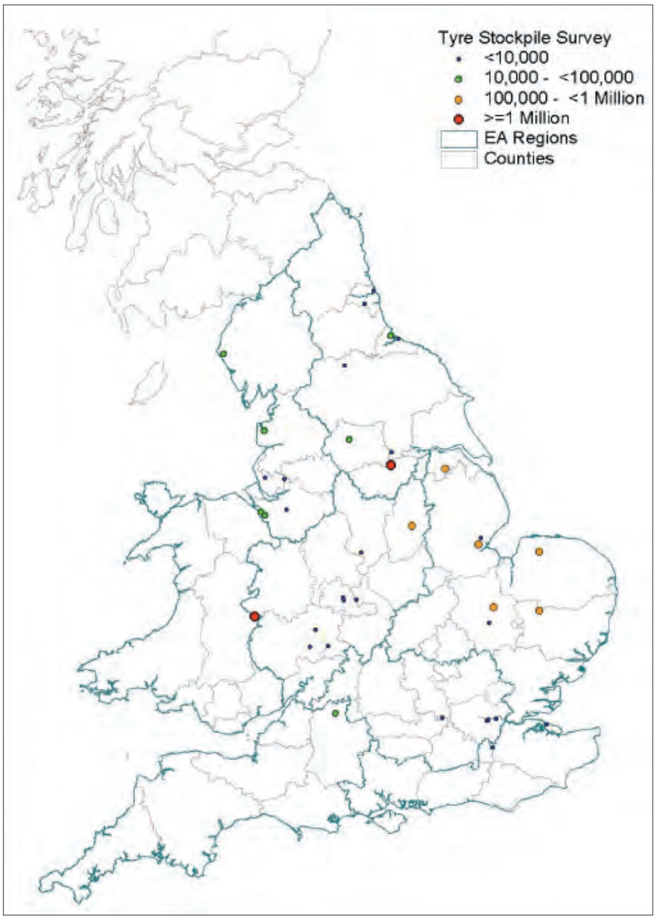
1. The potential impact to the health of nearby residents from the inhalation of toxic smoke following a fire at the site;

2. The potential impact to passing motorists caused by the impairment of vision due to smoke generation from burning tyres; and

3. The potential impact to controlled waters (i.e. the Magnesian Limestone Aquifer which outcrops at the site and nearby surface waters which are thought to receive baseflow from the quarry) through downwards percolation of contaminated fire water run off and leachate caused by the burning of tyres.

Under Environmental Protection Act 1990 Part 2A legislation the person liable is the person who caused or knowingly permitted the contaminants to be on the land (Class A Person). Where the Class A person cannot be found then liability passes to the current owner or occupier of the land (Class B Person). In this case, the Class A person was declared bankrupt and can no longer be found. In February 2002, possession reverted to Crown Estates under a process known as Escheat. However, Crown Estates can't be held liable as a Class B person as they do not assume any liabilities under Escheat and are not the owner of the land in the ordinary sense of the word. This resulted in the site becoming an orphan site, with the remediation costs being met through the public purse.

Figure 1. Tyre Stockpiles Mapped onto Environment Agency and County Boundaries © EA



Ironically, the day after the site gained contaminated land status, a large fire broke out involving over 1000 of the disused tyres situated within the former railway cutting adjoining the site. Six fire service appliances attended the scene and South Yorkshire Fire Service had to engage the use of a mechanical digger to get to the seat of the fire to bring the incident under control. The fire was eventually extinguished, but clearly demonstrated the potential risk posed by the site to cause a major pollution incident. As a result of a number of fire incidents recorded at the site, the Emergency Services then carried out a biannual exercise called 'Tyrian' in preparedness for a major fire, and Doncaster Council developed an Emergency Plan in case of a major fire.

The Hampole Quarry site was featured in an earlier article of the Chemical Hazards and Poisons Report, 'Public health and environmental risks associated with tyre fires' [1]. Health Protection

Panoramic Photograph of Hampole Quarry prior to Phase One Remediation © Environment Agency used with permission

Panoramic photograph of Hampole Quarry after to Phase two Remediation © Environment Agency used with permission

Agency staff, the Environment Agency and front line emergency services have real concerns over fires containing tyres as they have the potential to burn for significant periods (in the case of Hampole quarry, the potential was for several days or even months). Tyre fires produce a wide range of toxic, volatile, semi-volatile and solid contaminant species through a smoke plume and the release of mineral oils from the base of the stockpile under pyrolitic conditions (see Box 1). There were no water services available at the site and due to the irregular distribution of tyres, there were no fire breaks. If there had been a major fire incident, fire engines from Sheffield, Rotherham and Barnsley, would have attended; possibly leaving these regions without blue light cover. Due to the close proximity of the A1(M) road network and the London-Leeds railway line, a significant fire could have resulted in the closure of these busy transport links throughout the duration of the fire. The presence of a pylon on the site may also have required isolating part of the national grid to avoid the risk of electrocution.

Box 1. Tyre fire pollutants 1

Atmospheric pollutants

- The thick black smoke containing many hazardous chemicals, such as carbon monoxide and hydrogen cyanide as a result of incomplete combustion
- Dioxins, furans, PCBs, PAHs due to the combustion of benzene and chlorine in the tyres
- Particulate matter

Water and Land contamination

- During combustion heavy metals, phenolic compounds and PAHs leach out of the tyres. A significant amount of oil is liberated from each tyre during combustion
- These contaminants may leach into the ground or be washed into nearby watercourses by fire fighting water

The decision by Doncaster Metropolitan Borough Council to designate the disused quarry as a 'special site' gave the Environment Agency the statutory powers to take regulatory control of the site and undertake the necessary measures to remediate the quarry and address the environmental risks. Remediation of the site has been undertaken in a number of phases.

Phase One Remediation

The initial stage was to research and appraise the different methods of remediating the site. Careful consideration had to be given to the status of the quarry as being a Site of Scientific Interest (SSI) and to managing the ecological impact throughout the remediation process to ensure that any site restoration option provided the most suitable habitat for ecological recovery and improvement [2].

It was decided that the preferred solution was to completely remove and recycle the tyres. By September 2006, an access road had been built and around 8,000 tonnes of tyres had been successfully removed; 65% were recycled into engineered landfill drainage blankets, aggregate replacement, or as an alternative to fossil fuel; 17% were used for the manufacture of playground surfaces; and 18% were transferred to landfill [3].

Nevertheless, as the work progressed, it became apparent that the tyre mass had been hugely underestimated. Despite 8,000 tonnes of tyres having been successfully cleared, there were still estimated to be between 2,600 and 15,600 tonnes of tyres left to remove. Furthermore, during the early clearance stage the recycling levels were lower than anticipated due to the condition, age and discolouration of the tyres. At this point, the Environment Agency decided to cease the tyre clearance and evaluate alternative options.

Phase Two Remediation

The Environment Agency undertook extensive research to determine the most suitable remediation option. Having engaged with a number of international consultancies and carried out consultation with local stakeholders, it was decided that the remaining tyres should remain on the site, but be re-profiled into a regular shape and then covered over by an engineered cap [4]. The specifically designed cap is comprised of a 'geogrid' membrane: a layer of inert waste shale from a local source, finished with a layer of local limestone. It was important that the limestone mix was of a similar composition to the soil that occurs naturally in the area. The surface would eventually 'green over' as local plants re-established themselves across the site. Capping the tyres acts as a means of breaking the source-pathway-receptor linkage and significantly reduces the risk of combustion. As the buried tyres are extremely slow to decompose, the Environment Agency are confident that they will not produce a polluting leachate. Tyres are still used throughout the UK for landfill drainage blankets.

Work on the second phase of the remediation programme to establish the engineered cover system commenced on 7th January, 2008. The site was cleared of unnecessary debris and overhanging vegetation was cut back. Machinery was then brought onto the site to move and level the tyres across the entire site. The contractors commenced laying the geogrid membrane and by the end of January 2008, 30% of the quarry had been covered with the membrane, enabling the first layer of shale to be placed on top and levelled. The contractors had completed laying the final limestone layer by the 29th February 2008 [5].

Biodiversity specialists attended the site to ensure the final landform was suitable for ecological enhancement. This included minimising the risk of water ponding, and providing rock piles for reptiles and wind breaks to create micro-climates. The two phases of remediation have cost just under £1.8 million and were financed by the Environment Agency's Contaminated Land Capital Programme.

The benefits of this engineered cover included:

1. Stabilising the remaining tyres
2. Greatly reducing the risk of fire
3. Restoring the quarry and cutting as a valuable ecological habitat

Environment Agency staff have been working with ecologists from Doncaster Council and Yorkshire Wildlife Trust to manage the development and recovery of the site as a suitable habitat. They intend to harvest seeds from a local Nature Reserve and then sow these across the site to allow the re-establishment of local flora and enhance biodiversity.

Now that remedial works have been completed, the current owners, Crown Estates, and Doncaster Council will need to work together to consider long-term site management to ensure that the land develops as an attractive ecological habitat and to ensure that future tipping does not occur[5].

Hampole Quarry Prior to remediation 2006 © EA Used with Permission

References

1. **Welsh A, Crook P, Harman R (2003) Public Health and Environmental Risks associated with Tyre Fires. Chemical Hazards and Poisons Report, December 2003, Issue 1: 7 – 10**
2. **Environment Agency (2006). Hampole Quarry Update January 2006. Agency briefing note 2006.**
3. **Credential Automotive (2006) Hampole Quarry Case Study (http://www.credenv.com/doc_lib/HampoleQuarryCaseStudy.pdf)**
4. **Environment Agency (2005). Old Hampole Quarry Remediation – Engineered Cover System – Business Case. Internal report 2005.**
5. **Environment Agency (2008). Hampole Quarry Completion of Remediation - Fact Sheet March 2008.**

Acknowledgments

John Housham, Michael Hughes, Phil Waine, Amanda Best, Dave Walmsley and Sally Powell (Environment Agency)

Geraldine Annis-Potter (Doncaster Metropolitan Borough Council)

Strange Odours in the South-East

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Introduction

Our sense of smell is a valuable source of information about odorous chemicals present in the environment, and odours are often reported as early indicators of chemical incidents. Odours are carried by the air so if we know the direction of the wind, we can attempt to ascertain the source of the odour and investigate the incident. Sometimes, health effects are reported in association with odours; therefore, knowing the source of the odour and the chemical causing it are important from a public health perspective, in order to prevent or reduce exposure at receptors. This report details an incident which resulted in numerous notifications of odour complaints over a large area of England and where the source and cause of the odour was initially unknown. The probable source of the odour was finally found to have been generated hundreds of miles away with the meteorological conditions causing the odorous chemicals to be transported to this country. Fortunately, no actual health effects were reported as a result of the incident.

Incident summary

On the morning of 18th April 2008, as people were making their way to work, unusual odours/smells were reported to the Met Office, the BBC, Guys & St Thomas' Poisons Unit and the Chemical Hazards and Poisons Division (CHaPD) in London. These reports came from multiple locations in London and the South-East. The London Resilience Team was also fielding calls from the London Fire Brigade (LFB) and the London Ambulance Service (LAS) regarding the odour, with the possibility that there had been a wide scale event, though no casualties were being reported. Descriptions of the odour ranged from 'like a dead animal', to 'manure' and smelling of 'gas'. Several individuals who reported the smell initially speculated that the origin was local but became concerned when the smell remained even after they had travelled some distance from the place of initial detection.

Incident investigation

As one of the early descriptions of the odour reported to CHaPD was 'faecal', Thames Water was contacted in order to ascertain if the source of the odour was from the sewers or from a wastewater treatment plant. Thames Water verified that the odour was not water

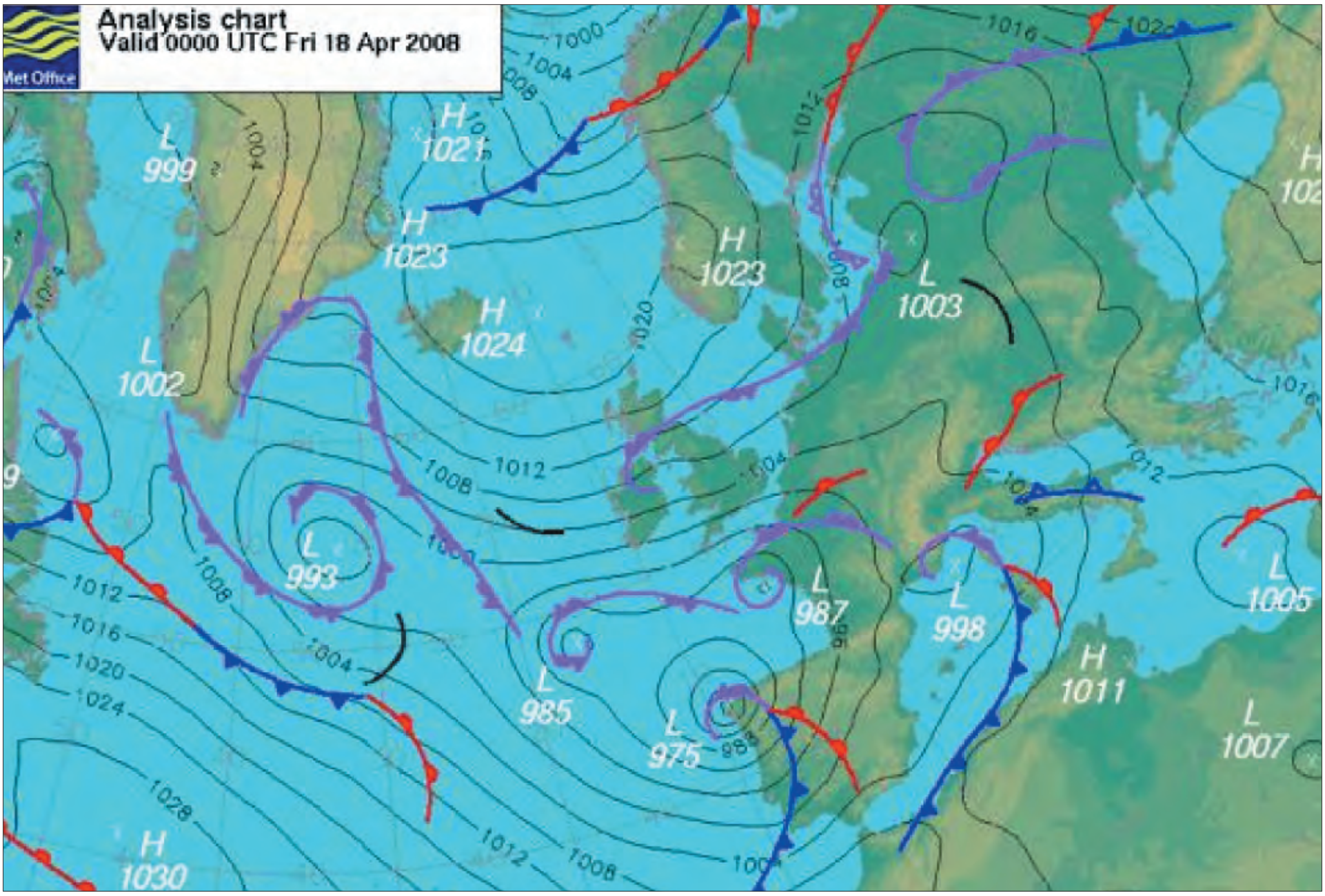

Figure 1: Met Office surface pressure chart for 00:00UTC on 18 April 2008.

related, adding to the possibility that the source of the odour was not generated locally.

Due to the high volume of calls received, and at the request of the Department for Environment, Food and Rural Affairs (Defra), the Met Office conducted an investigation into the possible sources of this smell, the results of which are detailed below.

Weather Situation

The UK most frequently experiences winds coming from the Atlantic Ocean where there is little pollution from man-made sources. However, during the period 17th-22nd April 2008 winds were blowing from an easterly direction. This meant that the air over some parts of the country, in particular the south east, had come from continental Europe. The relatively tight isobars in the surface pressure chart for 18th April (Figure 1) show that near-surface wind speeds were high, meaning that the air was rapidly transported from the continent to the UK at this time.

Back Trajectories

The Met Office's dispersion model - Numerical Atmospheric dispersion Modelling Environment, or NAME - can be used to produce both forward and back trajectories that simulate where air at a location will be dispersed to and where it has come from. NAME uses the most appropriate meteorological information from the Met Office's weather prediction models and is a valuable tool in determining the source of pollution events. To investigate the source of this odour, back trajectories were produced for 6 sites in the south-east (Figure 2). These show that the air reaching this region on the morning of April 18th had predominantly come from Belgium, The Netherlands and Germany over the preceding 4 days. Some of the air reaching northern East Anglia (e.g. Great Yarmouth) had also come from Russia. The model results also show that the air spent some time over Germany in relatively slack winds, where emissions could have accumulated; this suggests that the source of the odour was most likely in this area.

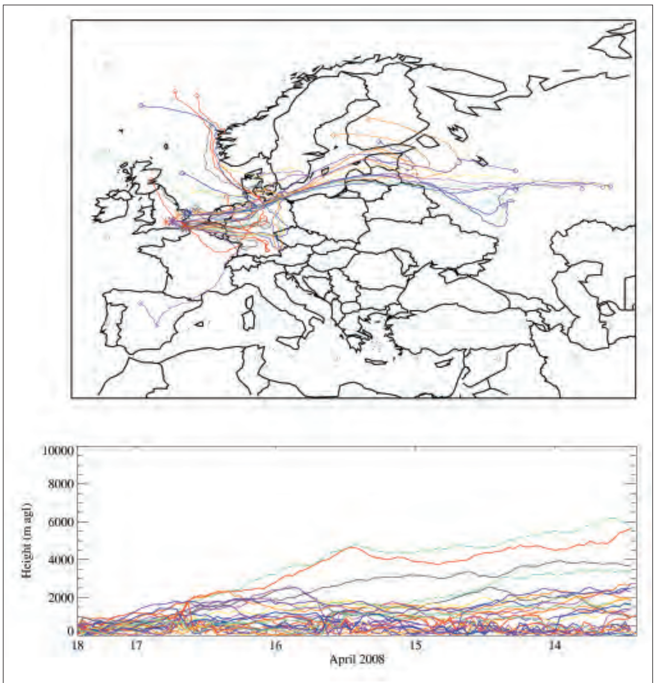

Figure 2. Back trajectory plots showing the transport of air over the prior 96 hours to 6 sites in the south-east of the UK at 11:00 BST on 18th April 2008. Five particles have been released from each site to capture some of the variability in the air mass movement.

The back trajectory height plots (lower plot in Figure 2) also indicate that much of the transport from the east was in the boundary layer, which was less than 1 km deep overnight 17th -18th April. This would have limited the vertical dispersion of any odour plume. The plots also show the gradual subsidence of the southward moving trajectories around the high pressure that was present in the North Sea region.

In contrast to 18th April, back trajectories for the same sites on 17th April (Figure 3) show that although the UK and the south-east experienced easterly winds at this time, the air had not passed over Germany and had a much cleaner higher-altitude North Sea transit. This helps explain why the odour was not noticed earlier in the week and why the onset appeared sudden as the wind pattern changed to come from the continent. Although the wind direction stayed from the east and south east until 22nd April, no further observations of odours were reported. Back trajectories show that the air at this time had passed much more rapidly over the continent and, importantly, had not stagnated over Germany, so that airborne concentrations would be much reduced near the supposed source region.

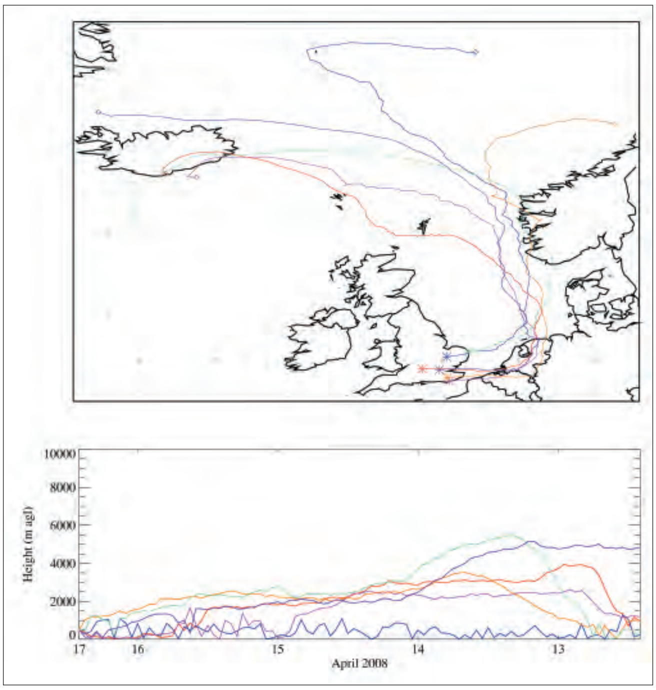

Figure 3. Single particle back trajectories plots showing the transport of air over the preceding 96 hours to 6 sites in the south-east of the UK at 11:00 BST on 17th April 2008.

Air Quality Observations

Transport of pollution from the continent to the UK is not uncommon when winds are from the east, but during these periods it is usually concentrations of anthropogenic air pollutants, such as particulate matter (PM10) and sulphur dioxide, that are increased. There can also be an associated reduction in visibility, but there are normally no reports of smells associated with these events. This makes the event of 18th April 2008 very unusual and uncharacteristic of typical European and Eastern European pollution events.

Observations from the UK's Automatic Urban and Rural monitoring Network (AURN) show no major increases in any concentrations of monitored pollutants (i.e. the main regulated species), which is contrary to what would be expected in European anthropogenic pollution episodes. However, the high wind speeds on 18th April would typically be expected to disperse any enhanced pollution level from continental European activity below problematic levels. This would also be expected to be the case for odours so the source strength of the odour on 18th April must have been exceptional for it to have been detected. The high volume of odour reports in the south-east of England compared to the rest of the country demonstrates that dispersion of the odour did occur downwind following the first detections in the UK.

An agricultural source might be expected to cause increased levels of ammonium (or ammonia), as this is one of the main waste products from animals and is released from slurry giving a sharp, pungent odour, like urine. Unfortunately, there are very few UK monitoring sites for ammonium to verify its presence or absence and no data are currently available for the south east. Further analysis will be conducted once data become available. PM10 measurements made by Defra's new Filter Dynamic Measurement System (FDMS) monitors did show a slight increase in the volatile fraction of PM10, but the chemical components responsible for this are unknown.

Health Effects

Fortunately there were no reported clinical health effects as a result of this incident.

Cause of the Odour

On 18th April, the National Farmers Union (NFU) issued a press release in which they stated that the odour was caused by Dutch farmers slurry spreading en masse at the end of the winter no-spread period (http://www.nfuonline.com/x26979.xml). A report in a German newspaper also suggested that the odour was prevalent in Hamburg in northern Germany on 16th-17th April. Here also the blame was apportioned to slurry-spreading. At present, the evidence for exceptional slurry spreading on the continent is circumstantial, but the introduction of the EU Nitrate Vulnerable Zone Directive over recent years in some European countries has prevented farmers from spreading slurry over an extended winter period. No reports or evidence for any other pollution incident or causal mechanism have been found so far and the conclusion reached at the time was that it was likely that favourable weather conditions during mid April 2008 encouraged mass slurry spreading in north-west Europe. This occurrence, combined with the wind situation at the time, led to the transport of strong slurry smells to the UK.

Summary

The apparent detection of the odour in areas from The Wash in East Anglia to the south coast (source Met Office Press Office) and beyond rule out a localised source somewhere in the south-east. Although the precise source of the smell is uncertain, the current evidence suggests that the cause was wide-spread agricultural slurry-spreading in Belgium, The Netherlands and in particular Germany. Odorous emissions associated with these activities were rapidly transported by fast easterly winds speeds to the south-east of the UK, arriving just in time for people's commute to work on 18th April.

Acknowledgements

This paper is part of a research project under the Engineering Doctorate (EngD) programme jointly run by the University of Surrey and Brunel University and is funded by the Engineering and Physical Sciences Research Council (EPSRC) and the Health Protection Agency.

Investigating an odour incident in a residential care home

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Introduction

Our sense of smell is a valuable source of information about odorous chemicals present in the environment. We can therefore assess the quality of the air we breathe on the basis of its odour. Environmental odours are often described as being either a 'nuisance' or as 'affecting health', however, some odours can cause symptoms in individuals even if there is no direct toxicological effect on the body (Shusterman, 1992).

Odour incidents can be upsetting to those exposed, and difficult to manage from a public health perspective. Therefore, as part of an Engineering doctorate programme, an Odour Checklist has been developed to aid with the management of such incidents (Smethurst, 2007). The checklist was used during a site visit by the HPA to aid the investigation of an indoor chemical odour complaint from a residential care home.

Indoor Odour Incidents

The major contributors to non-occupational indoor odour are volatile building materials, bio-odorants (mould, rotting food and animal derived odours), air fresheners, cleaning products, perfumes, deodorants, environmental tobacco smoke (ETS), human occupant odours (body odour), paints and solvents. Other sources of odour can include gas leaks and problems with waste water/sewer systems. Indoor air is often a complex mixture of chemicals; therefore, measuring an odorant problem can prove to be very difficult, especially when there is no obvious source or when different descriptors for the odour are reported.

Air conditioning systems can also draw odorous external air into buildings e.g. exhaust from vehicles, smoke from fires and chimneys, industrial emissions and waste management facilities; therefore, causing indoor odour complaints when the source is external.

Episode 1

On 14th September 2007, a care home worker entered a property under their responsibility and noticed a strong "chemical" odour. Two adult males with learning disabilities live at the home and are cared for by staff during the day. On this morning, the worker noted that, unusually, one of the residents had not awoken and reported that it took 30 minutes to rouse him, which the care worker attributed to the bad smell. No medical advice was sought for the difficulty with rousing. The staff member was also affected and experienced watering eyes, difficulty breathing, a dry mouth and tight throat. The home was evacuated and the fire service was called.

Investigation

Four firefighters attended the property and noted a smell similar to that of "marker pens", which they described as catching in their throats and being associated with a feeling of light-headedness. The firefighters searched the property thoroughly for a source, which they could not identify. The property was therefore ventilated in an attempt to dissipate the smell.

Four days later, despite ventilation, the smell was still perceptible inside the property and the care home manager arranged for plumbers and the gas company to investigate further, but no problem with the drains, gas supply or gas appliances could be identified.

During this time, the property remained unoccupied and at least three different care home staff periodically checked for odour. They continued to report bad smells and exhibit symptoms, including eye irritation, sore throat, slurred speech, tingling, dizziness, disorientation, and in one case vomiting was induced within minutes of entering the building, six days after the odour was first noticed. No medical advice was sought for the symptoms.

On two occasions during this period, Environmental Health Officers (EHOs) from the local authority attended the property, but could not detect any odour and did not experience symptoms.

HPA site visit

On 21st September, four local Health Protection Unit (HPU) and Chemical Hazards and Poisons Division (CHaPD) staff carried out a site visit to the property, along with an EHO. During the investigation, CHaPD staff used the Odour Checklist to ascertain more information from the care home staff regarding the odour, symptoms, and sampling/investigation. Health Protection Agency (HPA) staff and the EHO entered the property, but no odour or likely source could be identified. Care home staff were reluctant to enter the property.

The HPA concluded that the source of the odour was likely to have been transitory, and the HPU Consultant explained to the care home manager that although initially there may have been an odour stimulus, the persistence of the odour reporting and the continuing occurrence of symptoms may have been the result of pre-existing concerns. It was therefore recommended that the residents could return home.

Episode 2

On 2nd October, a week after the residents returned home, an odour was again reported at the property and it was again evacuated. All care home staff who entered the property detected the smell, which was described as "like something has died" and "like a sewer". One member of staff felt dizzy and nauseous, but did not seek medical attention.

Investigation

In an attempt to ascertain the source of the odour, the owners of the property, a Housing Association, agreed to employ a private company to carry out air and water testing. CHaPD were not informed or consulted regarding the sampling strategy used, nor did they receive the sampling results. The company reported that five 'machines' were placed in the property for seven days and no trace of any gas or odour was detected. The water samples that were taken showed no sign of bacterial growth and the water tanks were clean. The company therefore concluded that, along with the findings of the other investigating bodies, there was no source of odour.

The residents eventually returned to the property some weeks later and there have been no further incidents.

Discussion

At least ten people experienced symptoms, which they attributed to a bad odour in the property; however, a source for the odour was not identified by the extensive investigations that were carried out by six agencies. Although care home staff who entered the building continued to notice the odour and be symptomatic, during the same period none of the investigators could detect an odour, bar the firefighters who attended the scene on day one of the incident. It is likely that there was an objective source producing an odour which initiated both episodes; however the lack of evidence for odour after this points to a different aetiology for the ongoing symptoms experienced.

Mass psychogenic illness can be defined as the rapid spread of symptoms through a group of individuals who attribute the illness to an environmental exposure, in the absence of objective evidence of an environmental cause. Characteristics of mass psychogenic incidents include being more common in closed communities, symptoms spreading from older or authoritative individuals to younger and lower-status individuals, females being at greater risk than males, and they often occur in groups under particular psychological stress and are associated with odour (Boss, 1997) (for more, see page 22 of this report). In this case, some of the typical characteristics were present: an odour described as a 'chemical' provided the stimulus, staff were anxious and predisposed to view odour in the property as a threat to health, it occurred in a closed workplace and there was an absence of any evidence of cause. CHaPD would, therefore, conclude that the symptoms experienced were somatic.

A new and interesting finding in this incident regards the disparate and conflicting way that different people described the odour. It was variously described as: sour, sweet, unpleasant, chemical, bad eggs, sewage, marker pens, like something has died, and gassy. This could be because people were detecting normal household smells (e.g. perfume, dirty laundry, etc) but were misinterpreting these as threatening due to psychological stress. The inconsistency in description of the 'hazardous' odour may be an important finding in the study of psychogenic illness. In most cases, the HPA will only speak to one informant, but it may be useful to try to speak to more regarding what they can smell. More research into this is recommended, and this may be partially answered by the study that is being carried out in CHaPD London (Page, 2005).

Carrying out a site visit and utilising the Odour Checklist allowed the HPA to elicit more information and draw conclusions than would normally be possible. Researchers spoke to different members of staff, gained information on how knowledge about the odour was spreading, who could smell it, how it could be described and what symptoms had been experienced, none of which would usually be available to office-based CHaPD staff.

Acknowledgements

This paper is part of a research project under the Engineering Doctorate (EngD) programme jointly run by the University of Surrey and Brunel University and is funded by the Engineering and Physical Sciences Research Council (EPSRC) and the Chemical Hazards and Poisons Division, Health Protection Agency.

References

Boss L (1997) Epidemic hysteria: a review of the published literature. *Epidemiol Rev* (19): 233 – 43.

Page L (2005) Health and social impacts of chemical incidents. *Chemical Hazards and Poisons Report* (5): 36 – 37

Shusterman D (1992) "Critical review: The health significance of environmental odor pollution." *Archives of Environmental Health*, 47(1): 76 – 87.

Smethurst H (2007) Development of an odour complaints checklist for chemical incident response. *Chemical Hazards and Poisons Report*, (10): 20 – 26.

Foam parties: a case study and consideration of the associated health risks

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5. **University Nurse**

The scene

Foam parties are held in nightclubs and private venues, and involve dancing whilst large amounts of foam are sprayed from specially designed machines. The foam is sprayed out at short intervals, either directly into, or above, the crowd. As a result, the partygoers and the dance floor become covered in foam which can sometimes be up to a few feet deep.

A foam party was held at a nightclub in Sussex on 4th June 2008 and was attended by approximately 1000 partygoers. A large number of these were students. The foam was made on site by mixing 0.9 L of foam solution with twenty-five litres of mains water.

Sequence of Events

The environmental health officer (EHO) in the area was contacted on the 9th June 2008 by a parent of one of the students. The parent reported that the student had attended the party on 4th June and was now complaining of vomiting, nausea and abdominal pain. The parent also reported that a number of other students from the party had similar symptoms.

The foam party had been organised by a company who regularly provides such events. Apart from the need for an entertainment licence there is no restriction on foam parties in the Local Authority area. Foam parties happen occasionally at this location.

On the 10th June, the EHO informed the local Health Protection Unit (HPU) who immediately informed the University Health Centre. In the following few days a number of students who had been at the party attended the University Health Centre with a variety of health complaints: 3 students complained of gastrointestinal symptoms but did not need any further medical input; 1 student was seen by a GP at the University practice on 6th June with diarrhoea. This patient was reviewed on the 10th June and complained of continuing symptoms associated with right iliac fossa pain. These symptoms were severe enough to warrant admission to a local hospital where further investigation gave a diagnosis of campylobacter infection. Approximately 3-4 students presented with broken glass in their feet (one of whom needed referral for management of an associated soft tissue infection). Some other students were seen for other unrelated health problems but complained of skin irritation during the appointment. No students were seen with either conjunctivitis or eye irritation. This contrasts markedly with a report from a similar foam party in the same town in 2006, where approximately 10 – 20 students where seen by the University Health Centre complaining of eye irritation, several of whom required further assessment at the local hospital.

The University communications team issued a reactive press statement on 13th June 2008, having been contacted for information by BBC Southeast.

Investigation

The University Nurse initiated some active case finding by distributing her email address to affected students via a social networking site. Announcements were also placed on internal student and staff websites. In response to this action, 42 emails were received from affected students who had attended the party. The predominant features appeared to be;

- Onset of symptoms 24-48 hours after attending the party on 4th June
- All complained of vomiting (up to 15 times a day)
- Other associated symptoms (not experienced by all those unwell) were abdominal pain and diarrhoea
- Symptom duration of approximately 48 hours.

On 10th June, the HPU contacted Guys Poisons and St Thomas' Poisons Unit for further advice regarding the direct health effects of the foam. Guys Poisons and St Thomas' Poisons Unit then in turn contacted the Chemical Hazards and Poisons Division (CHaPD), London. A chemical safety data sheet for the foam was obtained via the EHO and examined by one of the Senior Toxicologists at CHaPD London. This showed that the substance was an amphoteric surfactant and so had the potential to cause irritation in the same way as detergents. However, there was no indication of other components in the product that could have contributed to the students' symptoms.

Learning points

Direct health risks from foam itself are minimal

The foam used at this particular party was made from a 1.2% solution of an aliphatic betaine (also known as coco amido betaine) in water; 0.9 L of this solution was diluted in 25 litres of water before the foam was made. Aliphatic betaines, especially when they are very dilute, are substances of low toxicity. They form part of everyday household products such as washing up liquids and shampoos. In common with shampoos and washing up liquids, the party foam can cause irritation to the eyes and sometimes the skin. Allergic reactions are also possible, although none was reported in this incident. If large quantities are swallowed, nausea and vomiting may occur shortly after ingestion. The literature reports one incident where foam at a foam party caused alkaline burns which resulted in a chemical conjunctivitis in six young men. The frequency of such effects after exposure to foam at parties is not known[1].

Indirect health risks of the foam are greater than the direct risks

The accident risk at foam parties is of greater concern than the direct effects of the foam. The foam makes surfaces slippery and conceals potentially hazardous objects. Dancers may cut their feet if bottles are broken on the floor, and there is one case reported of a teenager who slipped on a foam covered floor and hit his head on a metal bar that could not be seen[2]. Anecdotally, it has been suggested that malfunctioning electrical equipment could cause shocks that are transmitted through the foam[3], although there are no reports of this type of accident in the literature.

The greatest health risks at foam parties are from associated behaviours

Foam parties are associated with drinking alcohol, which on its own is a risk factor for accidents. The slippery concealed environment of the foam party can be disorientating and this further increases the accident risk precipitated by alcohol comsumption. The foam can be deep enough to cover the bottom half of the body and it is not uncommon for party goers to urinate and vomit into the foam. Vomiting into the foam will increase the risk of passing on any gastrointestinal infections.

In the incident described above, the clinical symptoms attributable to the foam were minimal. However, the abdominal pain and vomiting would fit with an outbreak of a virus, such as norovirus, transmitted by vomiting. In this incident, the campylobacter case was not thought to be related to the events at the party.

Potential risk reduction measures

Foam parties are attractive to young people but they do present an opportunity for risk taking behaviour. However, there are some common-sense measures that party-organisers can take to reduce risks. For example, glass can be banned from venues to minimise the risk of broken glass on the floor, rooms can be re-organised, hard objects can be removed if at all possible and any immovable sharp objects covered to protect party goers, flooring that is non-slip when wet will cut down the risk of falls and ground fault interrupters can be used on appliances that come into contact with foam, in addition to the usual safety checks[3].

Section 3 of The Health & Safety at Work etc. Act 1974 refers to duties of employers to others affected by their undertaking. In other words, employers have a duty to safeguard those not in their employment, including members of the public, contractors, customers and students.

Section 4 of The Health & Safety at Work etc. Act 1974 refers to duties of employers to ensure that premises are safe. It implies that persons in control of a premises must ensure that all equipment and substances are safe and without risk to health. It is important that employers consider their responsibilities, together with potential health risks, when planning foam parties on their premises.

The management of any foam party is key to controlling and reducing risks; excessive alcohol consumption and/or horseplay should be effectively dealt with by the management team to minimise potential harm. Although there is no firm evidence from this incident, vomiting into the foam may have caused the spread of gastrointestinal viruses. To maintain hygiene and avoid the spread of infections, when faecal contamination occurs in a swimming pool, the swimming pool should immediately close. This recommendation could be applied to foam parties by advising termination of the foam party should vomiting occur.

Signage could support the above approach by:

- warning of the dangers of the foam
- advising those who feel unwell to use the bathroom facilities (and not to vomit or urinate in the foam)
- advising that vomiting in the foam may result in closure of the party.

Conclusion

The major health risks at foam parties are those related to health and safety issues, which are exacerbated by dancing in a room full of foam and the associated alcohol intake. The direct health effects of the foam itself are likely to be minimal.

In this incident, the abdominal symptoms were most likely to be due to a viral illness and not the toxicological properties of the foam. It is not known if an environment full of foam has any effect on the transmission of viruses such as norovirus. Simple risk reduction measures have a role to play in reducing the adverse health effects of such parties.

References

1. Cather JC, Yee RW, Kilimanjaro-Davis H. Chemical conjunctivitis from a "foam party" (letter). *New England Journal of Medicine* 1996; 334: 474-475.
2. Mayr JM, Sorantin EH. Foam party risks (letter). *Injury Prevention* Mar 2000 6:1(73), 1353-8047.
3. Wikipedia on foam parties (accessed 19 June 2008) http://en.wikipedia.org/wiki/Foam_party

Emergency Planning

Carbon monoxide: elements of environmental public health surveillance

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Introduction

Although chemicals are ubiquitous in our environment, there are a number that have caused concern for health professionals and the public. These agents exist in a range of settings from a variety of sources: industrial emissions, agriculture, buildings, and domestic products such as household cleaning agents, toys, and cosmetics. Where a harmful chemical is widely distributed in the environment, even a small adverse effect may have significant consequences due to the large numbers of people potentially exposed. The need for surveillance of environmental hazards is therefore well recognised and presents specific issues.

Public health surveillance can be defined as the ongoing systematic collection, analysis, and interpretation of data on health events, together with their timely dissemination to inform prevention and control. More recent definitions cover more completely the pathway to disease by including information on distribution of risk factors/hazards and exposures, as well as outcomes (Thacker *et al*., 1996). This concept can be applied to all public health surveillance, and is particularly appropriate to environmental public health. Many chemicals are poorly characterised in terms of their association with adverse health outcomes. For some other chemicals, however, this relationship is well documented. In the case of carbon monoxide (CO), it is known that exposure causes mortality and morbidity (Ernst and Zibrac, 1998).

CO is produced by incomplete burning of carbon-based fuels, and poisoning may occur in domestic or occupational settings and recreational activities. Accidental non-fire-related CO poisoning is the focus of this report (intentional and fire-related exposures have distinct surveillance and prevention pathways). Such incidents can be prevented by simple measures including the adequate installation, maintenance and ventilation of appliances. Despite this, the Health and Safety Executive (HSE) report approximately 20 fatalities each year associated with CO poisoning (HSE, 2008) but this significantly underestimates the total burden associated with CO poisoning as they only capture mortality and ascertainment is unlikely to be complete.

Although the quantification of estimates of overall morbidity attributable to CO in the community is only suggestive (Croxford *et al*., 2008), the theory is that a typical "pyramid" picture could be used to represent the overall CO burden: a wide base to represent often overlooked and misdiagnosed morbidity (Heckerling *et al*., 1990) in the community; a smaller number of cases coming to the attention of and correctly diagnosed in primary care, Emergency Departments (EDs), those admitted to hospitals; and finally, at the top of the pyramid, deaths (Fouilh *et al*., 2003, Smith and Graber, 2007). However, the pattern of CO exposure and the impact of prevention strategies require further delineation, and calls have been made for systems to provide better information on occurrences to focus public health interventions (Bekkedal *et a*l., 2006; Fouilh *et al*., 2003; Graber *et al*., 2007; Ledrans *et al*., 2005; Smith and Graber, 2007). Preliminary steps towards this could be made by systematic data collection on confirmed fatal and non-fatal CO poisoning.

Various health agencies have a role when CO incidents occur, including the Health Protection Agency (HPA), the HSE, National Poisons Information Service (NPIS), and NHS hospitals. The HSE already routinely publish mortality figures, however, collecting further existing information from HSE and the other key agencies could provide a platform for developing a CO surveillance system.

We aimed to review ideas and experiences in CO surveillance, and to describe current CO reporting mechanisms in some of the key agencies in the UK, considering their potential value in a surveillance system.

Methods

We reviewed the literature on environmental public health surveillance and CO surveillance, identifying and grouping issues raised under key themes. We conducted semi-structured face to face or telephone interviews with contacts in the Office of National Statistics (ONS), HSE, and the NHS Information Centre, which holds Hospital Episode Statistics (HES). Interview questions covered the following main areas: data variables collected, method of data collection (e.g. computer database, paper record), time-scale in which data could be available. Notes were written at the time of interview and subsequently transcribed. Strengths and weaknesses of existing reporting by the contacted agencies were considered in the context of our own assessment of the requirements for CO surveillance and those suggested by the literature.

Results

1. Key concepts in environmental public health surveillance
As identified through the literature search, the principal aims of environmental public health surveillance described are (Morbidity and Mortality Weekly Report, 2001; Thacker *et al*., 1996):

- identification of populations at risk from environmental hazards
- responding rapidly to clusters and emerging threats from environmental hazards
- establishing relationships between hazards and disease
- optimising intervention and prevention strategies
- informing public health policy making.

To achieve these, an approach comprising three components is proposed (Hertz-Picciotto *et al*., 1996; Thacker *et al*., 1996):
1) hazard surveillance – the monitoring of the occurrence, distribution, and secular trends in toxic chemical agents responsible for disease or injury;

2) exposure surveillance - the monitoring of individuals for the presence of an environmental agent and/or its subclinical effects; and 3) health outcome surveillance. In principle, environmental public health surveillance would combine hazard, exposure, and outcome monitoring, but the feasibility and appropriateness of this varies for different chemicals, and other factors need consideration.

In establishing the public health case for surveillance of a chemical, the robustness of the evidence for the association between exposure to a chemical and harm, together with the effectiveness of interventions to mitigate harm, are significant factors. For many chemical and environmental hazards, including CO, there is a body of evidence suggesting that there is sufficient information and established methods to achieve the principal surveillance aims; for example, see reviews in the European Commission-funded Integrated Assessment of Health risks of Environmental Stressors project (INTARESE, 2006) and the World Health Organization International Programme on Chemical Safety (WHO/IPCS, 2008). But even where the risk of adverse effects from a chemical is unknown, a surveillance system could function with the following requirements (Hertz-Picciotto *et al*., 1996):

- high quality mortality and morbidity data with residence information
- accurate population data for denominators in rate calculations
- a wide range of information on environmental exposures, e.g. from sampling and/or modelling
- geographical linkage of the above three, with fine enough resolution for each to allow evaluation of effects from exposures in small areas.

2. Specific issues in CO surveillance

Published articles address general principles and requirements for CO surveillance and suggest possible approaches and data sources to achieve this (Bekkedal *et al*., 2006; Clifton *et al*., 2001; Graber and Smith, 2007; Graber *et al*., 2007). The key points identified are summarised below.

(i) The need for CO surveillance

This is based on supporting public health intervention and prevention activities by:

- measuring and monitoring the burden of CO poisoning over time
- identification of acute incidents where there is the possibility of ongoing exposure
- identifying high risk groups, settings, and modifiable factors
- providing epidemiological information on CO poisoning during large scale disasters when there are power outages
- examining the relative contribution of exposure sources.

Surveillance may also support research into chronic exposure to indoor CO associated morbidity such as long-term neurological sequelae in survivors of acute poisoning, the health effects of chronic low level exposure, and cardiovascular morbidity in chronic high level exposure.

(ii) Approaches to CO surveillance

In public health surveillance, a case-based and/or rate-based approach can be used.

Case-based surveillance for CO would involve collation of information on cases reported within hours or days of their occurrence. The notification of cases of CO poisoning has been described as 'indispensable to remove their causes' (Ledrans *et al*., 2005). Such reporting would stimulate follow-up to obtain more complete information, initially to identify cases where further public health action may be warranted, and then to fulfil other surveillance objectives. This approach constitutes a 'gold standard' in terms of timeliness and completeness, but it is resource intensive.

Rate-based surveillance involves using aggregated existing CO poisoning data to obtain rates across populations and/or over a time period. These data are often collected for various other purposes, for example hospital data and mortality data. Rate-based systems are less resource intensive, but have an inherent time lag between incident occurrence and data evaluation, and they lack completeness.

(iii) Data sources for CO surveillance

A fully integrated surveillance system could link data on health effects, exposure and hazard information. Hazard data from population-based surveys of housing may identify geographic areas and demographic characteristics of residents at risk of CO poisoning. Hazard and exposure data could be provided from a range of sources; fire and utility services are key potential sources, both respond to similar calls about gas leaks in homes and workplaces and both take carbon monoxide measurements. Care would be needed to avoid double counting of CO incidents. Exposure and health outcome data could be obtained through emergency departments (enhanced by rapid, non-invasive, pulse-oximeter measurement of carboxyhaemoglobin), hospital discharge data, and poisons services data.

(iv) Additional benefits of CO surveillance

Carbon monoxide is one of a number of public health concerns in the wake of large-scale disasters such as floods; developing CO surveillance could improve public health preparedness and emergency response. Furthermore, it could foster collaboration between diverse agencies to co-ordinate prevention activities. Benefits may be experienced beyond CO surveillance through improved technical capacity and co-ordination among health and environmental programmes to develop integrated national environmental public health surveillance.

Table 1: Types of information available on carbon monoxide poisoning cases from each data source

	ONS mortality data	Hospital episode statistics	HSE data
Age & sex	Yes	Yes	Some
Considered to be confirmed CO exposure	Yes	Yes	Yes
Cause of exposure	Some	No	Yes
Location	Yes	No	Yes
Detail of clinical outcome	Yes	No	No
Available in a standardised database	Yes	Yes	Yes
Frequency available	Quarterly	Annually	Real-time

3. Reporting of CO poisoning in the UK
Table 1 summarises the data on CO incidents collected by the agencies that we contacted.

Office for National Statistics data: The ONS hold only mortality data. There is a statutory requirement for all suspected or confirmed deaths from CO poisoning to be reported to the coroner, who will assign a code to the case and notifies ONS. CO poisoning can be coded as a secondary/underlying cause of death under 'injury and poisoning' (T58) in the International Classification of Diseases, 10th Revision (ICD-10). T58 includes all CO poisoning (T58) but there is also a subset of accidental CO poisoning (X45). The coroner's certificate is crosschecked by coders in ONS. The median time from a case being reported to a coroner to when it is coded to an ONS mortality record is approximately five months.

Hospital Episode Statistics: HES data are collated by the NHS Information Centre and are based on ICD coding. However, they do not consistently distinguish between accidental and non-accidental incidents. HES are aggregated statistics on admitted patients, but each HES record has a wide range of information about an individual patient including age, gender, ethnicity, and area of residence. Accident and Emergency (A&E) data collection has also started and is in the early stages of development. Specific reports on diagnoses over a particular period, including CO poisoning, can be requested from the NHS Information Centre.

Health and Safety Executive data: Incidents where someone has died or suffered a major injury attributed to CO in connection with gas (but no other carbon-based fuels) are reportable to HSE under RIDDOR (Reporting of Injuries Diseases and Dangerous Occurrences) legislation. Initial reports are usually made by National Grid within two hours of attending an incident. The gas transporter/supplier which investigates the incident must provide a brief description of the incident, causal factors, and remedial action taken or proposed to HSE. Where an incident does not involve a death, incident data reports are fed into a database managed by an organisation outside HSE. Regular analysis of these data is performed to show trends in causation, which are used to inform research, standards and practice.

Discussion

Surveillance is a foundation of public health and a critical step in developing prevention activities. The literature reviewed suggests a model of environmental public health surveillance incorporating data on hazards, exposures, and outcomes, to inform prevention activities at all possible levels. CO fits this model well. Work towards CO surveillance in the USA and France reported in the literature, largely using health outcome data sources, has produced encouraging results. In the UK, there are already reporting mechanisms for CO poisoning through HSE, ONS, and HES. These have significant strengths in terms of the contribution they could make to a surveillance system, particularly if integrated and combined with data from other sources such as NPIS/HPA.

Sources of ascertainment of CO poisoning cases used in published reports have included: mortality data; hospital in-patient data; hospital outpatient visits; emergency department data; poison centre records; and newspaper articles (Bekkedal *et al*., 2006, Clifton *et al*., 2001, Graber & Smith, 2007). In the USA, Bekkedal et al. combined data from all five of these sources and conducted a capture-recapture analysis to estimate the level of redundancy of cases found within the multiple data sources versus the number of additional cases; they also considered resources used to obtain the data and concluded that all but newspaper reporting could usefully form part of a surveillance system (Bekkedal *et al*., 2006).

In our work, we explored mortality and hospital in-patient data, and also data from HSE. Mortality data from ONS and HES data are well-established, standardised continuous data collection systems on confirmed CO poisoning that require limited resources to obtain. Their main weaknesses are their lack of timeliness and completeness, with variable or no data on the circumstances of the CO exposure. In contrast, HSE data are collected and available in real-time, with details of the CO exposure, but are resource intensive and have variable clinical outcome information. Plans are underway for ED data collection as part of the HES system and these will add valuable rate-based information. However, the representativeness of all morbidity data is limited, as many cases may not present to health care. Timeliness is critical to public health interventions in incidents of CO poisoning - there need to be established systems for urgent reporting to prevent further poisoning from the same source.

Perhaps the best approach for better characterising CO poisoning is through an incident reporting system to Health Protection Units (HPUs), with clear reliable case definitions (e.g. possible, probable, confirmed) from a variety of sources, conducting case identification and follow back investigations. This model is under development, and some of the initial steps in it's development are reported on page 18; it proposes liaison within the HPA and across a number of agencies. Gas suppliers respond to calls about gas leaks, while fire and ambulance services respond to similar calls about potential CO incidents, including non-gas incidents, in homes and workplaces, and take CO measurements. Reporting from these sources, in conjunction with reporting from EDs, GPs, and other agencies involved in incidents such as NPIS, could therefore give data on hazards, exposures, and outcomes that is timely and complete. However, there may be significant under-reporting and the rate-based systems such as HES and ONS with their strength in representativeness, could augment data from incident reporting to produce a more complete picture for ongoing surveillance.

Conclusions

The most common sources and causes of CO exposure are known, most adverse health effects following exposure are well-documented, and some effective interventions to minimise the risk are also well-established. Public health surveillance is essential to guide development and evaluation of prevention strategies, and can also address gaps in our knowledge of the epidemiology and outcomes of CO poisoning. The CO data sources explored in this work, other existing data sources, together with ongoing work to improve reporting during acute incidents and liaison across agencies, could provide a platform for CO surveillance.

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References

Anon, Updated guidelines for evaluating public health surveillance systems: Recommendations from the Guidelines Working Group. *MMWR* 2001, Vol. 50; RR-13.

Bekkedal M, Sipsma K, Stremski ES, Malecki KC, Anderson HA. Evaluation of five data sources for inclusion in a statewide tracking system for accidental carbon monoxide poisonings. *WMJ* 2006, Vol. 105 (2):36-40.

Clifton J, Leikin J, Hryhorczuk D, Krenzelok E. Surveillance for carbon monoxide poisoning using a national media clipping service. *Am J Emerg Med*. 2001, Vol. 19 (2):106-108.

Croxford B, Leonardi G, Kreis I Self-reported neurological symptoms in relation to CO emissions due to problem gas appliance installations in London: a cross-sectional survey. Environmental Health 2008, Vol. 7:34.

Ernst A, Zibrac JD. Carbon monoxide poisoning. *N Engl J Med*. 1998 Nov 26, Vol. 339 (22):1603-8.

Fouilh N, Sam-La, Saviuc P, Danel V. Carbon monoxide poisoning monitoring network: A five –year experience of household poisonings in two French regions. *Clin Tox* 2003 July, Vol. 41 (4):349-353

Graber J, Smith A. Results from a state-based surveillance system for carbon monoxide poisoning. *Public Health Rep*. 2007, Vol. 122 (2):145-54

Graber J, MacDonald S, Kass D, Smith A, Anderson H. Carbon monoxide: The case for environmental public health surveillance. *Public Health Rep*. 2007 Mar-Apr, Vol. 122 (2): 138-44

Health and Safety Executive (2008) Incidents relating to the supply and use of flammable gas, Table GS1. Source: Reporting of Injuries, Disease and Dangerous Occurrences Regulations (RIDDOR).

http://www.hse.gov.uk/statistics/tables/tablegs1.htm [checked 12.08.08]

Heckerling PS, Leikin JB, Maturen A, Terzian CG, Segarra DP. Screening hospital admissions from the emergency department for occult carbon monoxide poisoning. *Am J Emerg Med*. 1990, Vol. 8 (4):301-4.

Hertz-Picciotto I. Toward a coordinated system for the surveillance of environmental health hazards [Comment]. *Am J Public Health*. 1996, Vol. 86:638-41.

Integrated Assessment of Health Risks of Environmental Stressors in Europe (2006) INTARESE http://www.intarese.org/ [checked 12.08.08]

Ledrans M, Bretin P, Gourier-Frery C, Lecoffre C, e Moal J, Salines G. The practitioner's role in surveillance and information on environmental risks. *Rev Prat*. 2005 Nov 30, Vol. 55 (18):2016-25

Thacker SB, Stroup DF, Parrish RG, Anderson HA. Surveillance in environmental public health: issues, systems, and sources. *Am J Public Health* 1996, Vol. 86:633-8.

World Health Organisation/International Programme on Chemical Safety (2008) International Programme on Chemical Safety. http://www.who.int/ipcs/en/ [checked 12.08.08]

Developing best practice response to carbon monoxide incidents: a toolkit for health protection frontline staff

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We report on a pilot project to develop a decision support toolkit for Health Protection Units (HPUs) in the management of carbon monoxide (CO) incidents, from which a generic tool for other chemicals could be derived. This toolkit incorporates risk assessment and a best practice response algorithm.

Background

There is evidence from clinical practice that decision support systems with the following features are associated with the ability to improve practice[1]:

- Decision support provided automatically as part of clinician workflow
- Decision support delivered at the time and location of decision making
- Actionable recommendations provided by the system
- Computer-based systems.

HPZone[1] is one such web-based decision support system that caters for infectious diseases, but has not been validated for chemical and environmental hazards. It incorporates a risk management model, that is the Dynamic Risk Management and Priority Index (DRMPI)[2], recommended features for improving clinical and public health practice[3], and acts as an information depository (integrating data and knowledge management) and real-time response assistance tool. HPZone is currently used in HPA West Yorkshire, Surrey and Sussex and East Midlands. In 2007 an evaluation of its future role in LaRS was undertaken which recommended its adoption by the HPA. A similar support tool or bespoke adaptation of HPZone could enhance management of chemical incidents.

Carbon monoxide was identified as a prime candidate for developing a chemical decision-support toolkit because:

i) it is a common chemical scenario that HPUs encounter (see table 1);
ii) most incidents require complex multi-agency coordination to manage the acute response and secondary prevention;
iii) there is an exposure risk to the public as well as the emergency services first responders;
iv) it will improve early alerting and surveillance of CO poisoning;
v) it will contribute to the CO evidence-base which public health practitioners can use to improve public and media awareness and positively influence government policy and legislation.

Table 1: Casualties and fatalities from CO incidents reported in the CORGI CO Report (2007): Jan 2006-April 2007

Region / Country	Incidents	Fatalities	Casualties
East	7	4	15
London	12	9	34
Midlands	21	9	28
North East	7	2	40
North West	7	3	14
Northern Ireland	3	1	8
Scotland	9	5	14
South East	5	2	15
South West	4	1	9
Wales	9	6	14
Yorkshire	18	8	27
Total	102	50	218

Available at: http://www.trustcorgi.com/consumer/Documents/J3129%20Corgi%20Brochure_final.pdf

Current practice for management of CO incidents by HPUs is according to local protocol with assistance from checklists, CHaPD expert advice and the HPA Compendium. Recently an 'action card' for CO poisoning was developed by South West London HPU which details key actions, roles and responsibilities of various agencies [4].

The next step is to establish best practice for managing CO incidents incorporating risk assessment into an electronic decision support tool. This could help the HPA conform to its clinical governance requirements. The aim of this project was therefore to develop a best practice toolkit with response algorithm for the health protection response to CO incidents.

Methods

- Review CO incident types on CHaPD incident log and published literature
- Identify and map representative CO scenarios, themes and decision pathways
- Review available evidence (expert opinion and existing guidance) to identify best practice for managing CO incidents
- Write algorithm for managing CO incidents using real or simulated data
- Embed algorithm in a response toolkit

Results

CO incident types: CHaPD log and literature review
Forty seven potential or actual CO incidents were entered on the CHaPD incident log between 2006 and 2007. Although most encountered by the HPA were related to faulty domestic gas central heating appliances, for many the source was not documented. A literature review highlighted other settings and sources of CO poisoning in both the UK and worldwide.

In France, carbon monoxide poisoning is the top cause of death by acute poisoning[5]. A five year study in France reviewing household CO poisoning found that in 84% of incidents a source was identified. The most common appliances involved were vented heating systems followed by mobile heaters. In 63% of the incidents, faulty installation could be demonstrated.

Incidents in leisure venues such as indoor go-karting race tracks have been reported in the UK[6]. Outdoor leisure activities can also pose a risk: in the USA, vacationers wading or boating near operating motorboats have succumbed to CO poisoning, resulting in fatalities[7,8].

Large-scale CO poisoning has been associated with natural disasters due to severe weather conditions when power outages occur and so alternative energy sources are sought such as gasoline powered electrical generators, charcoal briquettes and portable heaters[9,10]. There have been many such reports from the USA linked to floods, hurricanes[11], and winter ice storms[12,13]. During the 2004 hurricane season in Florida, 167 people were treated for nonfatal CO poisoning, and portable gasoline generators were identified as the leading CO source[14]. Worryingly, 67% of affected households reported hearing CO public education messages and had correctly located and operated the generator outdoors. Flooding in Southwest England in 2007 was linked to two deaths from CO fumes emitted by petroleum-powered water pumping machinery.[15]

Cognitive mapping of typical CO scenarios

The source and settings identified from the literature review and CHaPD incident log were collated to form a comprehensive list for incorporating into the toolkit. These were mapped against the actions required to stop the source, and prevent further exposure to any persons, i.e. following the source-pathway-receptor conceptual model.

The actions were also categorised into standard chemical response phases: acute, post acute and post incident, which were noted to have been used in other checklists and toolkits.

In addition to incident reports, existing guidance such as the HPA CO action card[4], checklists[16,17,18] and the CHaPD Compendium entry[19] were referred to in order to establish, where possible, roles, responsibilities and lead agencies, relevant guidelines on standards and reference values and essential information for collection. The collation of information and scenario mapping was synthesised into a table *Elements required in a CO decision-support tool*, with the following column headings:

- Phase
- Task
- Specific details of action
- Priority of action and conditions
- Data collection fields
- Guidance and reference links
- Agency as source of info and agency as lead (if identifiable)

This table aimed to be as comprehensive as possible: the underlying tenet being that it could serve as a basis for writing the 'code' for HPZone CO incidents. The authors consulted developers and users of HPZone and were given a demonstration of its functionality. Headings and contents were therefore considered in terms of compatibility with features of HPZone, particularly the "integrated system of knowledge management" and "triggered protocol of rules based on experience".

In HPZone, actions or 'tasks' can be 'situation related' or 'case related' but these were not differentiated for this CO toolkit. The 'data collection fields' column was included to guide drop-down lists for the electronic database element of HPZone.

HPZone grades the priority of actions on pre-defined conditions. These grades ranged from: essential, highly recommended, recommended, seriously consider and consider. For CO incidents, it was felt that most of the actions in the acute and post-acute phase were essential and so conditions for action were not applicable. Notable exceptions could be: deciding the communications strategy and indications for a site visit. For these we attempted to define support criteria for action. In the post incident phase, there is more scope for applying conditions. Although priority gradings have been applied, conditions for actions still need to be set. The table was shared with the project team and amendments made accordingly. The final version informed the contents of the draft CO toolkit.

CO case definition

A case definition of CO was derived for discussion using a combination of clinical features, environmental monitoring and biological levels. An attempt was made to use these in an additive way to define chemical equivalents of the communicable disease definitions of possible, probable and confirmed case. The DRMPI[2] risk management model has an attribute of 'confidence in diagnosis', which was used as its basis.

Defining case definitions was not without challenges, and those presented here are not agreed but for discussion (table 2). One issue was the need for time and contextual information for chemicals, particularly dose and duration of exposure, which is not always necessary for infections. There was also tension between 'exposures' and 'cases' as one could have exposure to CO but not become a case. This issue is likely to be a challenge with other chemicals e.g. asbestos, where an exposure definition is not easy to define and there are no biological 'levels' to measure. On consultation it was suggested that perhaps the presence of a biological marker of CO poisoning alone could determine a case as confirmed, if this was taken to be the gold standard of testing for CO poisoning. Lack of familiarity with WHO guidelines was raised as a possible limitation, and although this could be addressed by training and access to guidelines in the toolkit, it emerged that environmental levels are reportedly rarely conveyed to frontline HPA staff. A more pragmatic alternative for environmental exposure could be the level at which commercial CO detectors are set, but these vary.

Draft CO toolkit

The main output of this project was a draft CO decision support toolkit with response algorithm which could be used by HPUs[20]. The features of the toolkit which are of 'added value' were:

- Case definition for CO – not usually done for chemicals
- Algorithm for action following notification of a probable or confirmed case of CO poisoning
- CO-adapted risk assessment tool
- Quick access via hyperlinks to relevant toxicology and environmental standards and reference values from the CHaPD Compendium, as well as generic chemicals information e.g. incident report template
- Interpretation of standards and reference values in the context of an incident

Table 2: Proposed case and exposure definitions for CO

DRMPI description for degree of confidence in diagnosis	Infectious disease example given in DRMPI	CO case / exposure category	CO case/ exposure definition
Available evidence suggests that the hypothesis is correct with an empirical probability in the range of 25% to 50%.	Alternative hypotheses equally likely	Possible exposure / case {Possible exposure}	Symptoms in affected person(s) consistent with CO poisoning AND Possible source identified AND CO concentration in air below WHO guidelines
Available evidence suggests that the hypothesis is correct with an empirical probability in the range of 50% to 85%.	Typical incident picture without conflicting information	Probable case {Confirmed exposure}	Symptoms in affected person(s) consistent with CO poisoning AND [EITHER potential source confirmed as emitting CO e.g. on home inspection OR CO concentration in air above WHO guidelines]
Available evidence suggests that the hypothesis is correct with an empirical probability higher than 85%.	Typical incident picture with increasing confirmation	Confirmed case {Confirmed exposure}	Symptoms in affected person(s) consistent with CO poisoning AND Elevated COHb level (*5%) in suspected case AND [EITHER potential source confirmed as emitting CO OR CO concentration in air above WHO guidelines]

- Alerting mechanisms
- Assigning incident status
- Roles and responsibilities
- Site visit criteria
- Communications checklist
- Information collection and incident log
- Report templates

Some of these features are found in HPZone and have been identified as good practice. To avoid 'reinventing the wheel', generic checklists and templates already developed by the Agency were reproduced or referenced in the toolkit.

A key feature of the toolkit is the algorithm for CO response in the acute and post acute phases (figure 1). It attempts to be user friendly by following the chemical incident concept of source – pathway – receptor (population) and response phases. The toolkit contains a separate table of the post incident phase actions which are not illustrated in the algorithm. These include surveillance, inter-agency liaison, more communications and information collection, debrief and public health advocacy. For each task, the specific actions, lead agency, priority, possible outcomes and guidance material links are detailed.

Discussion on CO toolkit development

The objective of developing an instrument to assist HPUs in responding to CO incidents has been achieved through the toolkit. There is a need for chemical specific toolkits just as there is for communicable disease; the latter is frequently used by HPUs.

This toolkit is a draft proposal and proof of principle that decision-support for chemicals can be developed. It has drawn on existing guidance, literature, expert opinion and experience. This toolkit stands alone but could be incorporated into existing electronic on-call packs used by HPUs or HPZone itself if the latter is implemented across the Agency, or in similar tools.

Recommendations

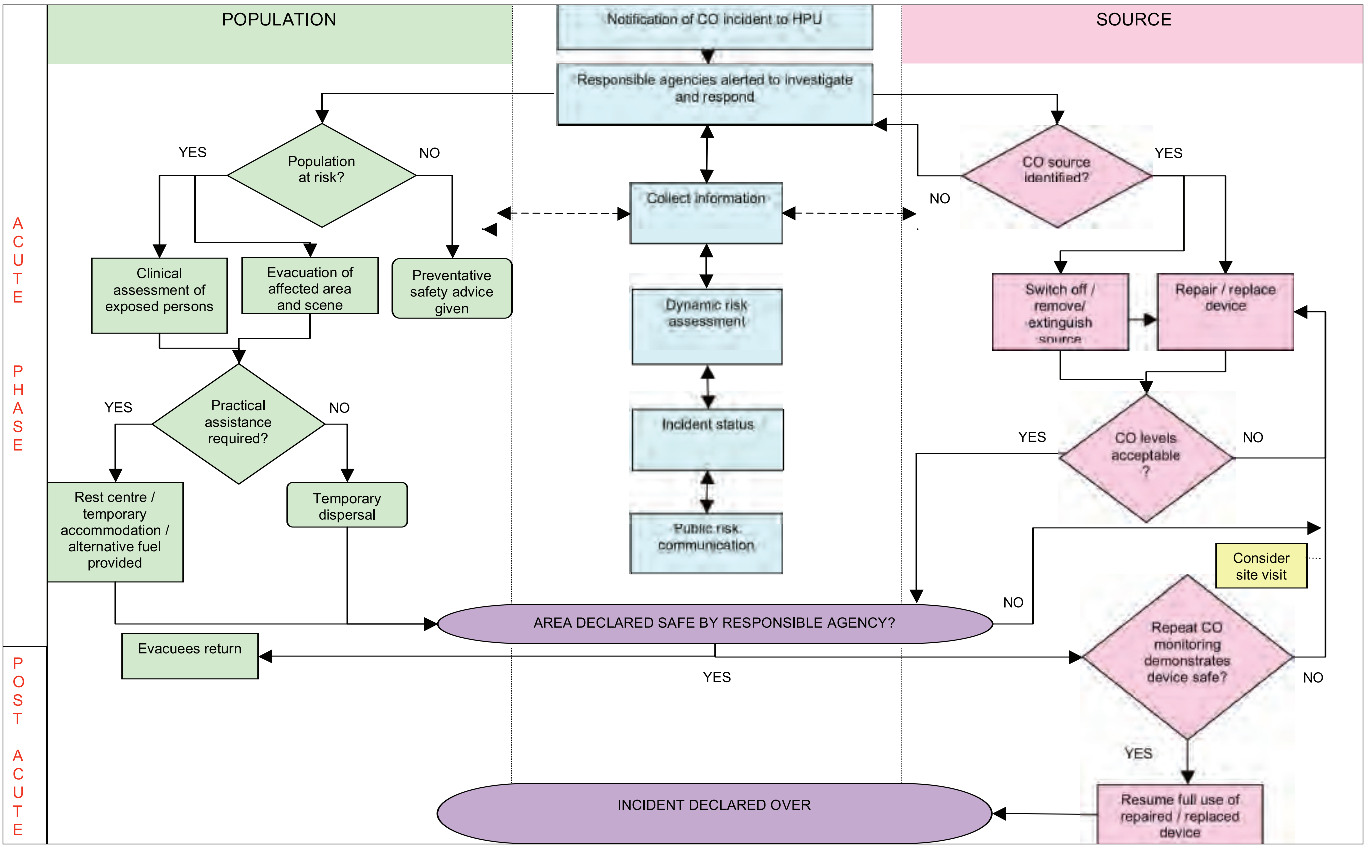
The next steps are wider consultation on the format and content of the toolkit culminating in utility testing.

To prevent duplication of effort and maximise opportunities for consultation and sharing outputs, a process for taking forward the toolkit, ultimately for final revisions and corporate sign-off, should be followed. However this organisational route is not yet clearly defined.

If demonstrated to be useful, the toolkit could provide a template for other chemicals that are also commonly dealt with by HPUs, e.g. asbestos and lead. These may be more challenging since they are often chronic incidents, and exposure levels are not easily defined. Nonetheless, this project could serve as a platform for a larger chemicals decision-support validation exercise.

If the CO toolkit, and chemicals in general, are to be incorporated into HPZone, a compatibility exercise needs to be carried out, in collaboration with HPZone developers, to identify modifications necessary for conferring chemical and environmental hazard functionality to HPZone. If chemical features cannot be easily transposed, a bespoke chemical HPZone may need to be considered.

Figure 1: CO response algorithm



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References

1 K Kawamoto et al. Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to sucess BMJ April 2005; 330; 765-772.

2 C Kara-Zaitri, R Gelletlie, H Barnes, N Black , D Walker, P Hatton, M Schweiger and D Wilson. The development of a Risk Management Model for Communicable Disease Control in the United Kingdom. Probabilistic Safety Assessment and Management. 2000. Universal Academy Press. 4, 2247-2253

3 M Schweiger Supporting good practice v2. 09 November 2007 (personal communication)

4 M Mindlin & R Ruggles. Development of a carbon monoxide 'action card' for public health practitioners. Chemical Hazards and Poisons Report Issue 10 September 2007. Available at: http://www.hpa.org.uk/chemicals/reports/hpa_chap_10.pdf

5 M Ledrans, P Bretin et al. The practitioner's role in surveillance and information on environmental risks. Rev Pract. 2005 Nov 30;55(18):2016-25

6 S Padfield & M Gent. Carbon monoxide poisoning at an indoor go-karting track. Chemical Hazards and Poisons Report. November 2006 pg 7-9.

7 Carbon monoxide poisoning resulting from open air exposure to operating motorboats at Lake Havasu City, Arizona 2003. MMWR Morb Mortal Wkly Rep 2004;53(15);314-318

8 Carbon monoxide poisoning resulting from exposure to ski-boat exhaust, Georgia 2002. MMWR Morb Mortal Wkly Rep 2002;51(37):829-830

9 N B Hampson & AL Stock. Storm-related carbon monoxide poisoning: lessons learned from recent epidemics. 2006 Undersea Hyperbaric Medicine 33 (4): 257-63.

10 J Graber et al. Carbon Monoxide: The case for environmental public health surveillance .Public Health Reports. March-April 2007 Volume 122. Available at: http://www.publichealthreports.org/userfiles/122_2/04_PHR122-2_138-144.pdf

11 Carbon monoxide poisoning after hurricane Katrina –Alabama, Louisiana and Mississippi. August-September 2005. MMWR Morb Mortal Wkly Rep 2005;54(39):996-1000 Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5439a7.htm

12 W R Daley, A Smith et al An outbreak of carbon monoxide poisoning after a major ice storm in Maine. 2000 J Emerg Med `8(): 87-93

13 P M Houck & N B Hampson. Epidemic carbon monoxide poisoning following a winter storm. 1997 J Emerg Med 15(4): 469-73.

14 D Van Sickle, D S Chertow et al. Carbon monoxide poisoning in Florida during the 2004 hurricane season. 2007 Am J Prev Med 32(4): 340-6.

15 BBC News. Rugby tribute to flood deaths duo. Saturday 4 August 2007 Available at: http://news.bbc.co.uk/2/hi/uk_news/england/gloucestershire/6930929.stm

16 F J L Goodfellow. Environmental Management of Chemical Incidents. Engineering Doctorate thesis. 2001

17 Faith J L Goodfellow, Virginia S G Murray, Sabèha K Ouki. Performance of Public Health Professionals in Responding to Chemical Incidents. Public Health Medicine. 2001; 3(3): 86-95.

18 Acute chemical incident checklist. Chemical Hazards and Poisons Division, London, HPA (unpublished)

19 HPA Compendium of Chemical Hazards and Poisons Carbon Monoxide. Available at: http://www.hpa.org.uk/webw/HPAweb&Page&HPAwebAutoListName/Page/1190384159835?p=1190384159835

20 HPA CO Toolkit Working Group. Carbon Monoxide Toolkit for Health Protection Units. Draft submitted to HPA by Dr Sema Mandal, SpR

Mass psychogenic illness and how to respond to incidents

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Introduction

Mass psychogenic illness (MPI), also known as epidemic hysteria, mass hysteria and mass sociogenic illness, has been reported for centuries and from all corners of the world. Episodes of MPI are not uncommon in the UK. Whereas in the past, episodes have been attributed to witchcraft, possession and malicious poisoning, today they are often attributed to perceived exposure to chemicals or radiation and can thus present a challenge for public health response.

What is mass psychogenic illness?
MPI can be defined as 'widespread, subjective symptoms thought to be associated with environmental exposure to a toxic substance, in the absence of objective evidence of an environmental cause' (Jones *et al*., 2000). Incidents involve two or more people who share beliefs as to the cause of their symptoms, although no source can be found that adequately explains the symptoms reported.

As there is no biological basis for the symptoms experienced, symptoms reported vary between incidents, but can also vary within the epidemic, making it hard to develop a case definition. Two syndromes have been described: 1) motor variant, where motor effects such as hysterical dancing, laughing, convulsions, pseudoseizures are more common, and 2) anxiety variant, where symptoms may include nausea, vomiting, headaches, shortness of breath and confusion (Wessely, 1987). The latter is more commonplace in the UK, associated with perceived toxic exposure.

What causes mass psychogenic illness?
MPI incidents are by their very nature diverse, with triggers and spreading mechanisms varying between incidents. Boss (1997) reviewed reports of MPI and found the following themes to be common:

- MPI incidents may be triggered by events, such as a real chemical exposure, but the response to these events goes beyond what can be toxicologically explained.
- The presence of an odour, real or perceived, can trigger incidents.
- The affected group are often already under psychological stress, such as poor work conditions, exam stress or concern about a nearby chemical company.
- Incidents are more common in 'closed' communities such as schools, workplaces, factories and hospitals.
- There is often an 'index case' from which the 'contagion' spreads, and spread is by 'line of sight', e.g., from friend to friend.
- Symptoms often spread from older or authoritative individuals to younger and lower-status individuals.
- Females are at a greater risk than males.
- Most incidents are short-lived, especially if in a school or workplace, but episodes in the community and family may last longer.

How common is mass psychogenic illness?
It is widely recognised that episodes of MPI are grossly underreported (Bartholomew, 2001) and there are no existing data on their frequency. This is due in part to the difficulties in recognising that an outbreak may be mass psychogenic, compounded by the minimal training in mass psychosis received by clinicians and health professionals.

As part of a study between Chemical Hazards and Poisons Division (CHaPD) and the Institute of Psychiatry (Page and Wessely, 2005), a random selection of incidents reported routinely to CHaPD were analysed and 4.6% (13/280) were classified as "probably mass psychogenic". Most of these 13 incidents involved considerable input from CHaPD and the local Health Protection Unit, the involvement of numerous emergency services and extensive sampling and monitoring, all at great cost. One case resulted in the closure of a school for three weeks, another the closure of a hospital Emergency Department, another the closure and evacuation of a town centre, and in others, people were decontaminated unnecessarily. The full analysis of these data is ongoing.

Most incidents of MPI are short-lived with transient symptoms; however CHaPD has been involved in longer-lasting episodes. Recent reports of incidents involving the Health Protection Agency (HPA) can be found on page 10 of this issue of the Chemical Hazards and Poisons Report, and in Issue 9 (Perret *et al*., 2007).

How can incidents of mass psychogenic illness be managed?
It is worth remembering that everyone - young or old, male or female, educated or uneducated, healthy or unhealthy - can experience psychogenic illness and that although there may not be a physically measurable cause, the symptoms experienced are real.

Although there is little evidence for the treatment of MPI, the following ways to manage incidents should be considered:

- MPI is difficult to differentiate from illness caused by chemicals or rapidly spreading infection, and is often a diagnosis of exclusion. However, quick recognition of an incident as mass psychogenic will prevent further spread, reduce anxiety and protect resources.
- Consider involving a behavioural scientist, psychologist or psychiatrist, with experience in this area, if possible
- If you do not think that this is a toxicological incident, say so as clearly as you can. People need simple, accurate information as soon as possible.
- Saying, however, that this is mass psychogenic illness is likely to be counter-productive – better to say 'unexplained', or 'stress-related'.
- Remove patients from the scene and separate the ill from not ill to prevent further spread.
- Minimise unnecessary medical attention and stress, and the presence of emergency services. These can all enhance the problem by adding to anxiety and confirming suspicions that the

situation is dangerous. Observe patients using a calm and authoritative approach.
- Encourage return to normal activity.
- Try to minimise the persistence of rumours and media reports, which can trigger relapses or new cases, by giving out clear health messages.
- Relapses may occur, especially if the episode lasts a long time.

Conclusions

Nearly 5% of the chemical incidents reported to CHaPD are potentially psychogenic in origin. MPI incidents have the potential to be extremely resource- and time-intensive. In order to reduce the psychological and financial burden of these incidents, it is important for public health practitioners to familiarise themselves with MPI.

References

Bartholomew RE. Little green men, meowing nuns and head-hunting panics. A study of mass psychogenic illness and social delusion. 2001; McFarland and Company Inc, North Carolina.

Boss LP. Epidemic hysteria: a review of the literature. *Epidemiol Rev* 1997; 19(2): 233-243.

Jones TF, Craig AS et al. Mass psychogenic illness attributed to toxic exposure at a high school. *NEJM* 2000; 342(2): 96-100.

Perrett K, Illing P, Clay J. An unusual problem in a primary school: a case of idiopathic environmental illness? *Chemical Hazards and Poisons Report* 2007; 9:9-10.

Page L, Wessely S. Health and social impacts of chemical incidents. *Chemical Hazards and Poisons Report* 2005; 5:36-37.

Wessely S. Mass hysteria: Two syndromes? *Psychol Med* 1987; 17: 109-120.

DAPPLE (Dispersion of Air Pollution and its Penetration into the Local Environment) Experiments and Modelling

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Introduction

Wind flow and pollutant dispersion in an urban area is a complex subject; the complexity is basically due to a very variable local source, the traffic, and the interactions between the wind conditions above roof level and the local urban geometry. However, there are characteristic features that can be recognised in many situations. One that has been extensively studied is the street canyon – a long, building-lined street – and "street canyon models" are included in most of the dispersion models that are used to estimate pollution levels in cities. Street canyon models clearly have their uses, but most UK cities are actually characterised by relatively short streets, meeting at intersections, where traffic movement might well be traffic light controlled. Crossroads are the areas where congestion is most probable, where emissions from vehicles are likely to be greatest, especially during acceleration, and where the local air flows generally cause an exchange of pollutants between the streets. It was these issues, and a good many more, that the DAPPLE projects set-out to investigate. Thus, DAPPLE selected an intersection as its focus, at a site that was typical of many to be found in UK and other European cities.

The study area is a region within a radius of about 300m or so of the intersection of Marylebone Road and Gloucester Place in central London. This area contains street segments of differing height to width ratios, as well as isolated tall buildings and open spaces and thereby encompasses the key urban elements and proves an ideal experimental site – previous use as a research site and the presence of long term urban air quality monitoring stations further enhances its value. Marylebone Road is a busy seven-lane dual carriageway and Gloucester Place a three-lane road, one way north-bound, with annual average daily traffic flows of about 83,000 and 18,000 vehicles per day, respectively. The backstreets are, however, extremely quiet and mainly residential. Air pollution levels in this area on a busy day vary enormously. One street away from the busy main road and fine particle concentrations, for example, may well be more than ten times less than they are at kerb-side in Marylebone Road. A large difference can also exist between one side of the road and the other. Contrasts become even more complex near intersections, as pollutants emitted from the traffic in one street are carried into the other by the wind – the wind at street level, that is, which is not at all the same thing as the wind above roof level.

To date, there have been two main DAPPLE projects and our intention is that there will be more. The first was funded by the Engineering for Health, Infrastructure and Environment Programme (EPSRC) and ran from 2002 to 2006. Its focus was primarily traffic pollution but the emphasis shifted somewhat towards emergency response as time progressed, a reflection of national and international concerns. This aspect became the full focus of the second large project that commenced in 2006, will run until 2009 and is funded by the Home Office (HO) Chemical Biological Radiological and Nuclear (CBRN) Science and Technology Programme. DAPPLE is by nature a multi-disciplinary activity; it involves a consortium of organisations, comprising the universities of Surrey (where the project is led), Bristol, Cambridge, Leeds and Reading, Imperial College and Golder Associates (UK) Ltd.

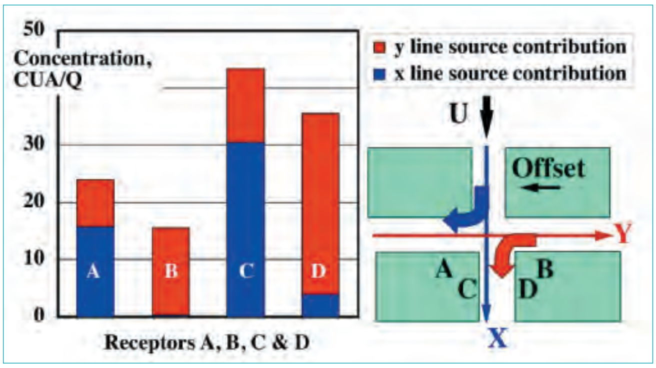

Figure 1: Previous work (Robins *et al*., 2002) with a small off-set array of identical blocks had demonstrated the importance of pollutant exchanges at an intersection. Pollutants from vehicles in streets X and Y are identified by colour. In the case shown, about 85% of the pollutant concentration in street X at D has actually come from street Y, whereas on the opposite side of X, at C, 70% has its origin in X and only 30% comes from Y. This figure formed the basis of the DAPPLE logo.

The DAPPLE methodology

The objectives of the EPSRC-DAPPLE project can be summarised as:

"to use field experiment, air quality monitoring, laboratory experiment and computer modelling to study the emission of pollutants from traffic on a busy urban street, the transport and dilution of those pollutants over short ranges by the wind and the resulting concentrations experienced by individuals in the study area."

HO-DAPPLE uses the same methodologies:

"to build further our understanding of the narrower topic of the short range dispersion of toxic materials in an urban area."

Throughout, a key intention is to use the data and knowledge gained to develop and evaluate so-called "practical" methodologies that can be applied, for example, to air quality management and assessment or to emergency response management and planning.

DAPPLE research addresses the processes that link the local sources of pollutants, the traffic, to the individual's exposure to pollution, the connecting processes being transport and dilution by the wind. Field experimentation and monitoring are central to this effort, with wind tunnel and (high-end) computing being used as the supporting technologies that allow the scientific issues to be investigated in a controlled and repeatable environment. In this paper, we summarise these activities in sequence and finish with a brief discussion of overall achievements and future plans. More detail is available from the DAPPLE web-site: www.dapple.org.uk.

The co-ordinated use of field, computational and wind tunnel studies is a major strength of DAPPLE, greatly enhancing the overall value of the individual activities and ensuring the project a high international standing. The modelling is therefore able to play an integrating role, bringing together the findings from a diverse range of field observations.

Figure 2: Aerial view of the Marylebone Road field site. Westminster City Council (WCC) Hall and Library are on the SW corner of the intersection with Gloucester Place. Tracer was released in York Street in many of the tracer dispersion experiments in 2003 and 2004. A more complex arrangement was adopted in later work.

Vehicle movement and emissions

DAPPLE provided the opportunity for the traffic-demand response control area of Marylebone Road in central London to be set-up as an urban laboratory. Initial validation of the output from the in-street detectors that are used to manage and control the traffic signals proved difficult. Traffic flow masking occurs because one detection loop crosses two lanes and this resulted in poor predictions during the high flow periods that occur for a large proportion of the time in Marylebone Road. Eventually, a reliable empirical approach was developed that adequately predicted traffic flow during the periods of masking. A model was then established that used the traffic flow data to predict emissions during sequential five minute periods. This made use of standard vehicle emissions factors and the vehicle composition and fleet characteristics for London.

Local-scale meteorology

Between 7 and 11 sonic anemometers were mounted at heights of 4 and 8m; mainly on lampposts and with additional mobile instruments deployed as required. Reference instruments were installed on the Westminster City Council (WCC) House and Library roofs at 18m above street level and at 180m on the BT Tower. Comprehensive short range weather forecasts and meso-scale model output were provided by the Met Office.

Figure 3: Two ultrasonic anemometers mounted on a lamppost. These instruments measure the three components of the mean wind and turbulence. Also mounted on the lamppost and visible towards the bottom of the picture is the instrumentation for measuring carbon monoxide (CO) concentrations.

Characteristic flow regimes at the intersection and within the street canyons were identified and related to the external (i.e. above roof level) wind conditions. Inspection of the probability density distribution of the horizontal wind direction revealed examples of bimodal forms at the intersection that were interpreted as intermittent flow switching. This arose when the external wind was at significant incidence to the street network. In such situations, the winds in the streets around the intersection could be modelled conceptually as the vector sum of a channelling and a recirculation vortex component. Analysis over a relatively broad range of roof-top wind directions demonstrated that channelling depended linearly on the along-street component of the roof-top reference wind, whilst the strength of the cross-street recirculation depended linearly on the component of this reference wind perpendicular to the street.

In general, the air flow balance at the intersection involved an input from two streets feeding flow and an output from two removing flow, together with vertical exchange with the flow above roof level. Flow switching implied that a flow entering from an "input" street left by either of the two "output" streets. The full, three-dimensional complexity of this motion was further investigated through computational and wind tunnel modelling in order to obtain deeper insight.

Air quality monitoring

Between 10 and 15 CO monitors and two joint CO and oxides of nitrogen (NOx) monitors were mounted in the vicinity of the intersection at heights of 4 and 7m; additional instruments were located indoors. Monitoring sites were selected to reveal concentration gradients across the streets and the intersection, and vertical variations within street canyons. This proved particularly valuable and data from selected monitors were used to identify the flow characteristics within street canyons when tracer experiments were undertaken. The CO data enabled an exploration of the variability of long term average concentrations in the vicinity of the intersection, which identified locations where monitoring recorded up to twice the mean from the nearby Automatic Urban and Rural Network (AURN) monitoring site. These results complement those from the exposure studies in demonstrating the degree to which even a well sited monitoring station can misrepresent air quality within its near-environment.

Tracer dispersion

The DAPPLE experiments were the first major tracer studies carried out in a European-style city. The extreme sensitivity of the detection system and the effectively zero background concentrations of the PFC (Perfluorocarbons) tracers implied that very low emission rates could be used, typically of order 100mg in 15 minutes. A single source was used in the first experiments but in later work this increased to three separate sources, with each emitting a different PFC. Between 10 and 16 sampling units were deployed at distances up to about 500m from a source, in some experiments collecting ten consecutive three-minute air samples and in others a single thirty minute sample. These units generally sampled at 1m above street level, but on occasions one was mounted at roof level and another located indoors. The entire technique proved to be exceptionally reliable and in excess of 50 tracer dispersion data-sets were obtained – far exceeding initial expectations and adding significantly to the small but growing collection of such data world-wide. An additional and novel set of experiments was also carried out with tracer released at a constant rate from a car moving along Marylebone Road. This leads to a very non-uniform distribution of emission along the road due to the stop-start nature of the traffic movement and this, in turn, poses some interesting challenges for dispersion modelling.

Analysis of the tracer studies has focussed equally on their use in developing and evaluating modelling, particularly at the operational level, and in building an understanding of short range dispersion processes in urban areas. These activities were not conducted in isolation and benefited greatly from the related wind tunnel and computational work and collaboration in the international effort concerning the dispersion of hazardous materials in urban areas.

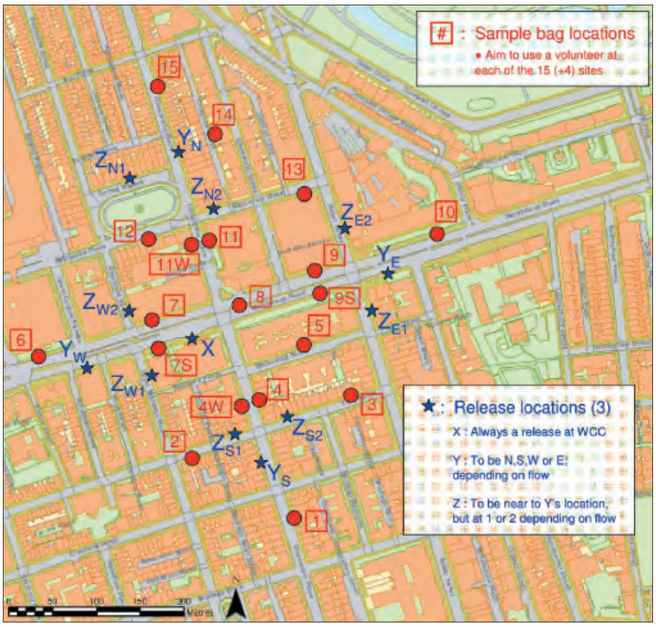

Figure 4: Site lay-out for tracer experiments in 2007 and 2008. Location X, on the pavement in front of WCC Hall, plus two other release locations were chosen according to the wind direction on the day. Three different trace gases were used, released simultaneously over a 15 minute period. The sampling locations were chosen so that there was always an upwind and two extreme lateral locations, no matter what the wind direction. Sampling began with the release and continued for 30 minutes, either as 10 three minute samples or as a single 30 minute sample. There was then a 15 minute period before the next experiment commenced. The inclusion of blank releases in the overall schedule confirmed that all tracer had cleared the study area during the time between releases.

Computer modelling and simulation

Extensive use was made of the Imperial College FLUIDITY code to model the dispersion of pollutants from sources resolved spatially at resolutions from 1 to 50m and temporally from 1s to 1hr, in the unsteady flow through the study domain. FLUIDITY uses the large eddy simulation (LES) approach in which the spatial and temporal development of all but the smallest scales of the turbulent flow is calculated explicitly. This requires powerful computer resources and involves long run times but the output allows investigation of issues such as the relative importance of sources of variability in the concentration field due to both the emissions and the flow. The simulations also contributed greatly to the analysis of the exposure measurements.

Other computational activities, spanning the full range from conventional CFD (Computational Fluid Dynamics) to simple empiricism, were carried out to examine the use of such procedures in an operational framework. This had two strands, one relating to standard air quality concerns and the other to emergency response and management; indeed, the work forms a major contribution to the current international effort in the latter context. Air quality modelling concentrated on the application of “advanced” regulatory models, typified by Atmospheric Dispersion Modelling System (ADMS). These models predict ensemble average behaviour, though the most advanced may also provide an indicator of variability, whereas tracer studies are always single realisations from an ensemble, frequently in circumstances where variability is large. Thus, the reliability of conclusions describing model performance may be quite limited unless a large number of individual realisations is available. The 50 or more examples provided by the tracer experiments constitute a most useful body of data for this purpose.

Wind tunnel modelling

Like the LES studies, the wind tunnel work was not intended to be a faithful representation of all features in play at the field site but a tool to interpret and extend the field work. Comprehensive and detailed flow and dispersion data-sets were collected that were suitable for model evaluation work at all levels from the empirical to CFD. This involved both steady and finite duration emissions and particular attention was given to variability, through measurement of the mean and mean-square concentration field and construction of probability density functions of concentration. Travel times and concentration rise and decay times for short duration emissions were also determined and related to the building scale and the wind conditions above roof level. Another key subject of the wind tunnel work was the likely variability between repeat experiments (see Figure 5). These wind tunnel data have already been widely used outside of the DAPPLE project, for example, within the Natural Environment Research Council (NERC) - Universities Weather Research Network (UWERN) urban boundary layer programme.

Flow processes at the intersection and in the street network were investigated in detail through a combination of flow visualisation studies and flow and dispersion measurements. An important issue in the development of “operational” urban dispersion models is the nature of the exchanges between the flow in street canyons and the free flow above roof level. Consequently, detailed mass flux measurements were carried out at the main intersection and in the surrounding streets. This revealed the balance between advection along the streets, exchanges between the streets at the intersection and exchanges with the external flow, providing essential information for guiding model development. Vertical exchanges in the vicinity of individual tall buildings were also investigated.

Flow visualisation studies were found to be a great aid in the interpretation of wind field measurements at the intersection. These showed the complex, unsteady, three-dimensional nature of the flow field and explained the "flow switching" phenomena deduced from field observations as a consequence of the unsteadiness. Transfer between streets proved not to be intermittent but a continuous process within the three-dimensional motion. The overall unsteadiness resulted in horizontal wind measurements at a fixed point appearing to switch direction as, for example, the structure and scale of the interacting flow fields changed. Another very important use of the flow visualisation material is in the field of the public communication of the research.

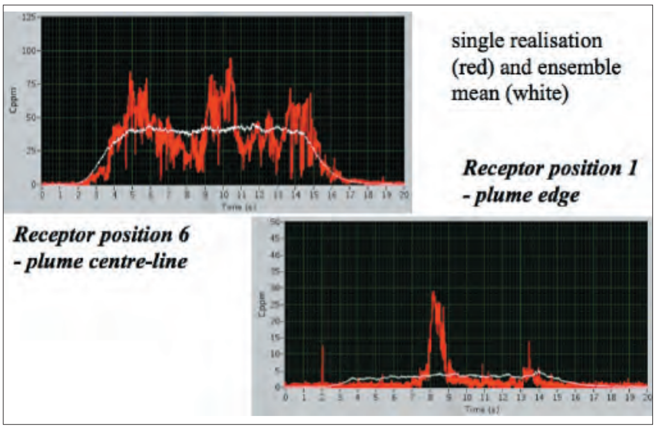

Figure 5: An illustration of dispersion variability in a short duration emission, as seen in the wind tunnel. The white traces show the average behaviour, from an ensemble of about 100 repeated experiments, the red traces a particular example from the ensemble. Fluctuations about the average are large, even in the centre of the cloud (top), but most noticeably toward its edges (bottom). Additional sources of variability exist in the field; e.g. due to large scale meteorological changes and traffic movement. The average is what operational dispersion models predict but it's the single event that has to be managed in an emergency.

Exposure studies

The project exceeded expectations in providing new insight into individual exposure to pollutants in a real city, where people experience high concentrations during the short times they spend close to traffic emissions. An unprecedented number of samples was collected: 394 during the first campaign and 603 during the second. These covered individual exposure to particulate matter (PM) smaller than 2.5 μm (PM2.5), ultra-fine particles and CO along two different routes, using five modes of transport. The analysis of the exposure data also revealed that the local background and kerbside monitoring stations were not representative of the exposure of individuals to PM and CO at and around the street canyon intersection. An exposure visualisation technique was integrated with the measurements during the second campaign. This was found to be a valuable environmental risk communication tool when used for presenting exposure data to both technical audiences and laypersons.

The relationship between individual exposure and its controlling factors was found to be extremely complex, made more so because people frequently move through a city faster than the pollution. Individuals were seen to pass through clouds of pollutants, that were themselves drifting through the street systems some minutes after being emitted, and thereby experienced surprisingly high short-term exposure. Taken together with results from field experiments in York, the data highlighted the main causes of elevated concentrations of traffic related CO within urban streets. The most important factors were found to be:

i) the level of traffic congestion, rather than the total vehicle flow, during daytime periods,
ii) the overall height to width ratio of the street canyons,
iii) the circulation in street canyon vortices leading to a build-up of pollutants in leeward locations and resulting CO concentrations up to 3 times higher than at windward locations, and
iv) the proximity to busy intersections.

The marked spatial and temporal concentration variability suggests that successful modelling of personal exposure would require accurate representation of both traffic related emissions under varying traffic regimes and the complex turbulent dispersion mechanisms within the street canyons.

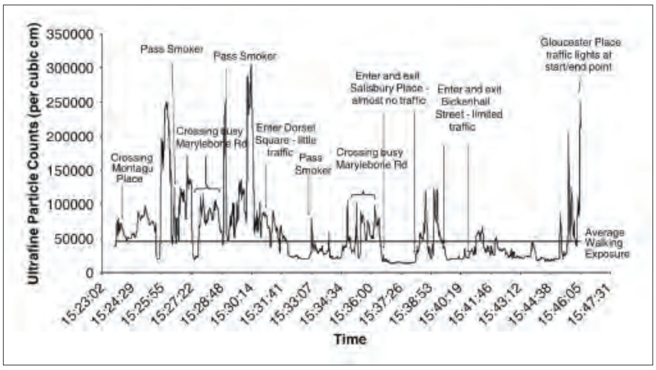

Figure 6: Record of fine particle concentrations experienced during a single pedestrian journey over an exposure route, showing critical locations along the route and some associated environmental conditions. Two exposure routes (one along Marylebone Road and the other, the one illustrated here, including substantial sections along quiet back-streets) and five modes of transport were studied (foot, bicycle, private car, taxi and bus). "Volunteers" carried instrumentation to measure concentrations of CO (10 second resolution), ultra-fine particles (1 second resolution) and total PM2.5. Exposure sampling was carried out at three fixed times during the day.

Several implications emerged for measures to reduce exposure in urban locations. For example, significant benefits in street canyon air quality could result from reductions in the level of congestion within the street network, since this would potentially reduce the local emissions from a large number of individual vehicles. Simple strategies for limiting personal exposure were also devised and evaluated. As an example, the benefits of pedestrians and cyclists using side streets rather than main roads when travelling through Central London were assessed. This showed a significant reduction in overall exposure to traffic related pollutants.

Final comments

The project benefited greatly from the genuine interest and involvement of stakeholder groups in London; the APRIL (Air Pollution Research in London) network played a prominent role in ensuring this. The smooth operation and success of the field work would not have been possible without the willing support and co-operation of the local authorities, in particular Westminster City Council and Transport for London, and the provision of meteorological data by the UK Met

Office. This, in turn, attracted others to want to work at the site and the overall added-value to the project proved substantial. For example, additional experimental work was carried out that addressed the integration of an exposure visualisation system with conventional exposure measurements, the suspension and movement of dust from road surfaces and the velocity profile in the lower 200m of the urban atmosphere.

As already noted, the quality and quantity of output in all aspects of DAPPLE exceeded expectations and, consequently, analysis work and publication will continue for some time. Increasingly, this will involve groups that were not directly involved in the project itself. Throughout, the consortium provided regular feedback of research progress and outputs to the full range of stakeholders. Regular reports and presentations were given to local authorities, agencies and other interested groups in London. The APRIL network played a major role in these activities, activities that will continue as the analysis of DAPPLE data progresses further and new research is carried out.

The DAPPLE Consortium has shown that it is possible to carry out extensive multi-disciplinary field work in central London without undue difficulty and that a successfully managed project can attract significant added-value. We intend to continue to use the Marylebone Road site as an "urban laboratory"; for example, to consider particulate pollutants, outdoor-indoor pollutant transfer and dispersion over greater fetches (for which the current work defines the "source term").

Acknowledgements

The DAPPLE consortium would like to acknowledge the Engineering and Physical Sciences Research Council (EPSRC) and the Home Office CBRN Research and Technology (R&T) Programme for funding the research. Special thanks are also due to the many organisations and individuals who have supported the fieldwork; in particular to Transport for London, Westminster City Council, Camden Council, The Met Office and The Health and Safety Laboratory. The lead contacts at the organisations comprising the DAPPLE consortium are: University of Surrey, Prof A Robins; University of Bristol, Prof D Shallcross; Cambridge University, Prof R Britter; University of Leeds, Prof A Tomlin and Prof M Bell (now at Newcastle University); University of Reading, Prof S Belcher; Imperial College, Prof H ApSimon; Golder Associates (UK) Ltd, Dr S Arnold.

Bibliography

DAPPLE Publications

www.dapple.org.uk

Cheng, H., Hayden, P., Robins, A.G., Castro, I.P., 2007. Flow over cube arrays of different packing densities. Journal of Wind Engineering and Industrial Aerodynamics, 95, p.715-740.

Kaur, S., Nieuwenhuijsen, M.J., Colvile, R.N., 2007. Fine particulate matter and carbon monoxide exposure concentrations in urban street transport microenvironments. Atmospheric Environment 41 p.4478-4810.

Kaur, S., Clark, R.D.R., Walsh, P.T., Arnold, S.J., Colvile, R.N., Nieuwenhuijsen, M.J., 2006. Exposure visualisation of ultrafine particle counts in a transport microenvironment. Atmospheric Environment 40 p.386-398.

Kaur, S., Nieuwenhuijsen, M., Colvile, R., 2005. Personal exposure of street canyon intersection users to PM2.5, ultrafine particle counts and carbon monoxide in Central London, UK. Atmospheric Environment 39 p.3629-3641.

Kaur, S., Nieuwenhuijsen, M., Colvile, R., 2005. Pedestrian exposure to air pollution along a major road in Central London, UK. Atmospheric Environment 39 p.7307-7320.

Belcher, S.E., 2005. Mixing and transport in urban areas. Phil. Trans. Roy. Soc. 363 p.2947-2968.

Dobre, A., Arnold, S.J., Smalley, R.J., Boddy, J.W.D., Barlow, J.F., Tomlin, A.S., Belcher, S.E., 2005. Flow field measurements in the proximity of an urban intersection in London, UK. Atmospheric Environment 39 p.4647-4657.

Namdeo, A.K., Bell, M.C., 2005. Characteristics and health implications of fine and coarse particulates at roadside, urban background and rural sites in UK, Environment International. Vol 34, p.565-573, 2005.

Arnold, S., ApSimon, H., Barlow, J., Belcher, S., Bell, M., Boddy, D., Britter, R., Cheng, H., Clark, R., Colvile, R., Dimitroulopoulou, S., Dobre, A., Greally, B., Kaur, S., Knights, A., Lawton, T., Makepeace, A., Martin, D., Neophytou, M., Neville, S., Nieuwenhuijsen, M., Nickless, G., Price, C., Robins, A., Shallcross, D., Simmonds, P., Smalley, R., Tate, J., Tomlin, A., Wang, H., Walsh, P., 2004. Dispersion of Air Pollution & Penetration into the Local Environment - DAPPLE. Science of the Total Environment, 332, p.139-153.

Colvile, R. N., Kaur, S., Britter, R., Robins, A., Bell, M.C., Shallcross, D., Belcher, S.E., 2004. Sustainable development of urban transport systems and human exposure to air pollution. Science of the Total Environment, 334-335, p. 481-487.

Arnold, S., ApSimon, H., Barlow, J., Belcher, S., Bell, M., Britter, R., Cheng, H., Colvile, R., Dobre, A., Kaur, S., Martin, D., Neophytou, M., Nickless, G., Price, C., Robins, A., Shallcross, D., Smalley, R., Tate, J., Tomlin, A., 2004. DAPPLE - Dispersion of air pollutants and their penetration into the environment. International Association for Urban Climate Newsletter, Issue No. 7, October, 2004

Robins, A.G., 2003. Wind tunnel dispersion modelling - some recent and not so recent achievements. J Wind Eng, 91, p.1777-1790.

Robins, A.G., Savory, E., Scaperdas, A., Grigoriadis, D., 2002. Spatial Variability And Source-Receptor Relations At A Street Intersection. Water, Air, & Soil Pollution: Focus, 2, (5-6), p.381-393.

Environmental science

Fly-tipping and health protection

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Introduction

Fly-tipping is the illegal deposit of waste onto land which does not have a licence to accept such waste; for example, private land, road sides and lay-bys. Fly-tipped waste can include: black bagged household waste; large domestic items e.g. fridges and mattresses; commercial waste; builders' rubble; tyres; garden refuse; litter; and soil. Hazardous materials such as waste oil, car batteries, asbestos, clinical waste and chemicals can also be dumped illegally.

Box 1: Origin of the word fly-tipping

"Tipping" is an old British term for dumping, which first appeared around 1838. According to the Oxford English Dictionary, "tipping" is defined as "the tilting up of a truck so as to discharge its contents; the emptying out of the contents of a truck, etc., by tilting; dumping." While "tipping" originally referred to rubbish being dumped from a truck, it has since become a synonym for any sort of refuse disposal.

The "fly" in "fly-tipping" is a bit more obscure but appears to be derived from "to fly" in the familiar aviation sense. Since the early 19th century, "fly" has been British (and sometimes American) slang for "wide awake" or "clever," and currently carries the connotation in Britain of "crafty" or "dishonest" so "fly-tipping" is rubbish dumping done sneakily (and illegally) [1].

Fly-tipping can pose a serious threat to the environment, human health, and wildlife. The costs associated with cleaning up illegally dumped waste and litter are significant. In the UK, around £100-£150 million is spent investigating and clearing up fly-tipped waste each year2. In addition, fly-tipping can serve as a magnet for additional illegal waste dumping. Fly-tipping can undermine legitimate waste businesses where illegal operators undercut those operating within the law[2].

Fly-tipping and the Law

Local authorities (LAs) and the Environment Agency (EA) have legal powers to tackle fly-tipping. The EA investigates the larger scale incidents of fly-tipping, for example, those involving hazardous waste and those involving organised gangs of fly-tippers. LAs tackle the clean-up of fly-tipping on publicly owned land, including roads and lay-bys. Fly-tipping on private land, such as the front or rear garden of a house, is the responsibility of the owner/occupier to remove.

There are several pieces of legislation relating to fly-tipping. In England, Wales and Scotland, the main legislation is the Environmental Protection Act 19903, Sections 33 and 34 (Box 2).

Box 2: Environmental Protection Act

Section 33, Environmental Protection Act 1990 states that an offence is committed if:

- a person has deposited/knowingly caused/knowingly permitted the deposit of controlled waste in or on land and either:
  that land does not have a waste management licence in force in relation to it; OR
  the deposit is not in accordance with a waste management licence.
- a person has treated, kept or disposed of controlled waste or knowingly caused or knowingly permitted the treatment, keeping or disposal of controlled waste in or on land and either:
  that land does not have a waste management licence in force in relation to it; OR
  the treatment, keeping or disposal is not in accordance with the licence.
- a person has treated, kept or disposed of controlled waste in a manner likely to cause pollution of the environment or harm to human health

Section 34, Environmental Protection Act 1990
A waste holder (any person who imports, produces, carries, keeps, treats or disposes of controlled waste or, as a broker, has control of such waste) is under a 'duty of care' with regard to that waste and it is an offence if he fails to take all measures applicable to him in that capacity as are reasonable in the circumstances to:

- prevent another person from committing an offence under section 33 EPA
- prevent the escape of the waste from his or another person's control; and
- to transfer the waste to an authorised person or to any person for authorised transport purposes and to provide that person with a written description of the waste.

(Fly-tipping Guidance from the Fly-tipping Stakeholders Forum)[4]

The following punishments can apply:

- In the Magistrates Court, fly-tipping fines can be up to £20,000 and/or 6 months' imprisonment. If the case goes to Crown Court, fines are unlimited and can lead up to 2 years' imprisonment and up to 5 years if hazardous waste is dumped.
- Where fly-tipping involves the use of a vehicle, the driver of the vehicle can be prosecuted, as can the owner of the vehicle.
- The police have powers to seize vehicles used for fly-tipping.

Figure 1: Fly-tipped soil (Image: CHaPD, London)

Extent of fly tipping

Fly-tipping is a global problem and it has been a huge challenge in both developing as well as developed countries (Box 3). International trade in waste from the industrial world to developing countries for the purposes of recycling or specialised waste disposal has the potential to result in impacts on public health in the countries receiving this waste.

Box 3: International fly-tipping incidents

Mass Needle Stick Injury in Children from the Western Cape[5]

On 15 September 1999, used needles and syringes were illegally dumped on a soccer field in the Western Cape, South Africa. Children gave one another injections using the syringes and played darts with the discarded needles. A total of 54 children were involved in this incident, where the primary concern was the possible risk of infection from HIV and other blood-borne disease. All children were eventually found to be free of infection but only after a long period of anxiety and significant clinical intervention.

Toxic waste and health effects in Abidjan City, Ivory Coast[6]

In 2006, 500 metric tons of toxic waste was dumped in the city of Abidjan, Ivory Coast. In the following days and weeks, thousands of people presented signs of poisoning. Analysis of the waste established a mixture of sodium hydroxide, phenols, mercaptans, hydrogen sulphide, hydrocarbons and other chemicals used to clean oil transporters' tanks. The final toll was 8 dead, dozens hospitalized, and about 100,000 medical consultations.

Nationally, fly-tipping is a huge problem as reported in the "Flycapture" database. "Flycapture" was launched by the EA in April 2004 and requires all local authorities and the EA to submit monthly returns on the number, size, waste types and location of fly-tipping incidents in their area. The database provides a national picture of the fly-tipping problem faced by local authorities. Initial headline statistics from the third year (2006/07) of Flycapture indicate [7]:

- 2.6m fly-tipping incidents were dealt with by LAs in England – a 4.5% increase from 2005/06
- Fly-tipping costs local authorities alone almost £76m a year to clear up
- 77% of fly-tips involved household waste.

Local authorities provide useful information leaflets for the public to inform them about the hazards of fly-tipping and most provide a dedicated phone number for public so that they can report any fly-tipping incidents. The public can also contact the Environment Agency directly via the Fly-tipping/Pollution Hotline on 0800 807 060.

Fly-tipping and public health

Box 4: Fly-tipping incident in the UK

A recent article on the BBC website reported the dumping of more than 1,000 litres of toxic waste near a beauty spot. The waste, in five plastic drums, was believed to have been residue from illegal diesel laundering. A local councillor illustrated the potential harm that could have been caused, "It was very near a watercourse and it's very near some beautiful lakes so the damage could have been catastrophic" [8].

Fly-tipping poses a serious threat to public health (Box 5). Areas used for fly-tipping may be easily accessible to people, especially children, who are vulnerable to potential physical injury, infection and chemical hazards associated with waste. Uncontrolled disposal of waste is hazardous to the general public, in particular when the rubbish contains items such as syringes, asbestos or industrial waste. Rubbish containing food will attract rodents, vermin and insects to the area, some of which may carry disease.

As a nuisance issue, fly tipping affects the quality of the living environment and thus, can also affect the quality of life of the communities living in these environments – although these impacts can be more difficult to quantify.

Box 5: Health hazards related to fly-tipping

Fly tipping can cause health hazards, including:

- Physical hazard – cuts & injuries from protruding nails, broken glass or sharp metals resulting infection.
- Chemical hazards from toxic fumes, dust and chemically polluted water
- Health effects from fire resulting from burning waste/dumped oil (figure 2)
- Diseases spreading from rodents and insects

Traditionally, it is the responsibility of the EA and LAs to manage fly-tipping. Although fly-tipping has possible consequences for public health, there are no identified guidelines or policies in place for Health Protection Units (HPUs), Primary Care Trusts (PCTs) or the regional Chemical Hazards and Poisons Division (CHaPD) to become involved in incidents involving fly-tipping.

Figure 2: An empty warehouse fly-tipped with tyres and set alight (Image: CHaPD, London)

The Health protection Agency (HPA) has an important role in protecting the health of the population. HPA has access to wide range of expertise (for example on public health, toxicology and environmental science) based at local (e.g. HPU), regional (e.g. CHaPD) and national level to risk assess, and to provide support and scientific/medical advice on known health effects of toxic chemicals (for example asbestos), poisons and other environmental hazards. Timely advice from local HPUs in dealing with hazardous fly-tipped waste will enable the identification of potential risks and appropriate intervention. It may be useful for public health practitioners and HPUs to engage with colleagues from the LA and EA to develop suitable communication mechanisms to ensure timely alerting to public health threats arising out of inappropriate waste disposal.

Conclusion

Fly-tipping has increased over the last few years and continues to be a problem. Fly-tipping is a crime with potential public health implications. Currently, no guidance or policy exists for HPUs or PCTs to risk assess the health hazards posed. A suitable mechanism should be developed for rapid communication to prevent and deal with potential health threats posed by such activity.

References

1. The word detective, 2003 (http://www.word-detective.com/040503.html) [accessed 06.08.08]
2. Environment Agency (2008) Fly-tipping (http://www.environment-agency.gov.uk/subjects/waste/1029679/1032559/?version=1&lang=_e) [accessed 06.08.08]
3. Environmental Protection Act 1990. (c.43), London: HMSO.
4. Fly-tipping Stakeholders Forum (date unknown) Fly-tipping Guidance (http://www.naturenet.net/law/flytip.pdf) [accessed 06.08.08]
5. de Waal N, Rabie H, Bester R, Cotton MF (2006) Mass needle stick injury in children from the Western Cape. J Trop Pediatr. 2006 Jun; 52(3): 192-6. Epub 2005 Nov 16
6. Bohand X, Monpeurt C, Bohand S, Cazoulat A (2007) Toxic waste and health effects in Abidjan City, Ivory Coast; Med Trop (Mars). 2007 Dec; 67(6): 620-4
7. Department for the Environment Food and Rural Affairs (2007) Fly-tipping: National database - Flycapture 2006-2007 data
8. (http://www.defra.gov.uk/environment/localenv/flytipping/flycapture-data.htm) [accessed 06.08.08]
9. British Broadcasting Corporation (2008) Toxic waste found at beauty spot (http://news.bbc.co.uk/1/hi/northern_ireland/7476253.stm) [accessed 06.08.08]

Comprehensive assessment of waste management strategies at the local level: the NLWA case study

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At any scale of decision, the setting of waste management (WM) policies and the assessment of their efficacy are complex exercises. Not only do several objectives have to be reached at the same time, but numerous interested groups interpret the strategy's outcomes from different points of view, sometimes adopting contrasting criteria, such as cost, technical feasibility, energy efficiency, health and environmental impact, climate change impacts, and availability of suitable locations.

With this research project we aim to address this complexity when WM strategies set and implemented at the local level are assessed. We propose that local WM strategies have to be tackled with a comprehensive assessment approach, by integrating several tools.

The task to define a comprehensive evaluation approach is mirrored by the involvement and collaboration, besides the UCL Environment Institute and Chemical Engineering Dept. investigators, of different project partners: the North London Waste Authority; the North London Waste Plan; the Environment Agency for England and Wales; and the Health Protection Agency - each contributing with specific expertise, either in the planning or technical sectors of WM.

The context

Several constraints are imposed on waste managers in Europe. On one side are policy issues; the EU Directive on Landfill and the Waste Framework Directive set a precise hierarchy, favouring waste minimisation and mandating a marginal role for landfilling. On the other side are physical constraints: a pair of centuries of production of industrial waste coupled with a heavy reliance, also for municipal waste, on landfills – mainly derived from filling former quarries – have drastically reduced the availability of empty spaces.

To reach the goals set by EU Directives, the UK national Government and Regional Governments have developed detailed WM strategies and support a range of Offices and Agencies in their implementation. The main objectives can be summarised as:

- increase waste prevention and reuse;
- increase recycling of resources and recovery of energy;
- meet and exceed the Landfill Directive diversion targets for biodegradable municipal waste;
- increase diversion from landfill of non-municipal waste;
- secure the needed investments in infrastructure at all level of the waste hierarchy.

Significant achievements have already been made by the UK in the last decade, with recycling levels for municipal solid waste currently exceeding 25% at all national levels. Debate still remains intense on the level of adoption of technologies for the recovery of energy from waste: incineration; advanced thermal treatments, such as gasification; and anaerobic digestion. It is also important to evaluate how energy from waste performs with respect to the recycling of the different waste fractions. The effect of plant scale, and the combined production and distribution of heat and electricity are particularly relevant issues.

The contribution of the waste sector to the reduction of carbon emissions can also be relevant. The "Waste Strategy for England 2007" underlines that the biodegradable waste disposed in landfills accounts for 40% of methane and about 3% of greenhouses gas emissions. Due to the absolute total amount of these emissions, the waste sector is expected to contribute strongly to the achievement of the reduction goals set for the UK.

Life Cycle Assessment of Waste Management and Scenarios assessment for the North London Waste Authority (NLWA)
Governments targets require a step-change to implement the diversion of household and commercial waste from landfill, still the final destination of about 55% of UK municipal solid waste, and to support the realisation of an innovative infrastructure comprising recycling facilities and energy recovery plants.

It is therefore necessary to assess the effects of these changes on the local scale, where WM strategies are designed and implemented.

EU Directives highlight the necessity of life cycle thinking in WM. Life cycle assessment (LCA) is a widely used and internationally standardized methodology that quantitatively supports life cycle thinking. LCA accounts for the environmental aspects of a product or a service, in this case WM, from "cradle to grave", from raw material acquisition through production, use and disposal (1).

When assessing WM policies, LCA estimates the scoring of different scenarios, such as the energy efficiency of incinerating plastics, paper, and biodegradable wastes to generate heat and electricity, versus recycling and composting. LCA accounts for the emissions and the resources consumption associated with providing virgin materials instead of recycling them, or the pressures on the environment of different fuels that could be replaced by the energy generated from waste.

Landfilling of waste always scores poorly on LCA, due to the high impact on the depletion of natural resources, the lack of savings of raw materials from recycling, and the lack of energy and heat recovery that replace the baseline energy mix.

Why the North London Waste Authority (NLWA) case study?
Local Authorities are designing and implementing WM strategies to reach national targets; therefore, they have a pressing need to define a comprehensive methodology for the assessment and ranking of the

several options. But, differently from the strategies established at the national scale, local strategies have to indicate the number and type of facilities required to support strategic objectives and allocate the areas where construction has to take place. These decisions have to be checked against the physical reality of the land served by the waste collection and disposal authorities, and are verified by consultation with several stakeholders, including the residents of the area.

In this project, the LCA is applied to a local case, the NLWA, to support the evaluation of their preferred option of municipal solid waste management. The LCA will be integrated with the evaluation of the techno-economic performance of innovative technologies (2), with the estimate of the cost of the whole collection/treatment system, and with the analysis of the spatial and social constraints relevant for the area served.

Several scenarios of WM will be set up and evaluated using the Waste and Resources Assessment Tool for the Environment (WRATE), a software package developed by the Environment Agency. The scenarios will be modified to estimate the effect of the collection schemes, reflecting the different solutions currently adopted by the waste collection authorities in the area, to acknowledge that collection and treatment are both part of a single system, and that both affect the overall WM's efficiency.

The NLWA is the second largest waste disposal authority in England in terms of the tonnage of municipal waste that it handles and, from a wider perspective, the area is characterised by a mix of business types and wastes being generated. It faces the challenge that waste has typically been transported out of the area to landfill sites further afield and it must now manage a greater proportion of its waste locally. In terms of timing, this research project fits well with the development of a new waste strategy and a new waste planning framework. Although these WM planning documents are being developed from a different basis, and so may result in different outcomes, they provide data and information which are relevant for this project (3).

The North London area is one of the most densely populated in the whole country; recent statistics show that the population is continuing to rise to above the national average, in most cases. The North London area has more people aged between 20 and 39 than the national average and ethnic diversity is greater than for England as a whole. Four of the constituent Boroughs are within the top 20 most deprived areas in the country, with two within the top 10. The main employment sector is services, but all North London boroughs have higher unemployment rates than the national average.

The main elements of the North London Joint Waste Strategy (NLJWS) are: to minimise the amount of municipal wastes arising; to maximise recycling and composting rates; to manage municipal wastes in the most environmentally benign and economically efficient ways possible through the provision and co-ordination of appropriate WM facilities and services; to ensure that services and information are fully accessible to all members of the community; and to maximise all opportunities for local economic regeneration. The strategy also seeks to ensure an equitable distribution of costs, so that those who produce or manage the waste pay for it.

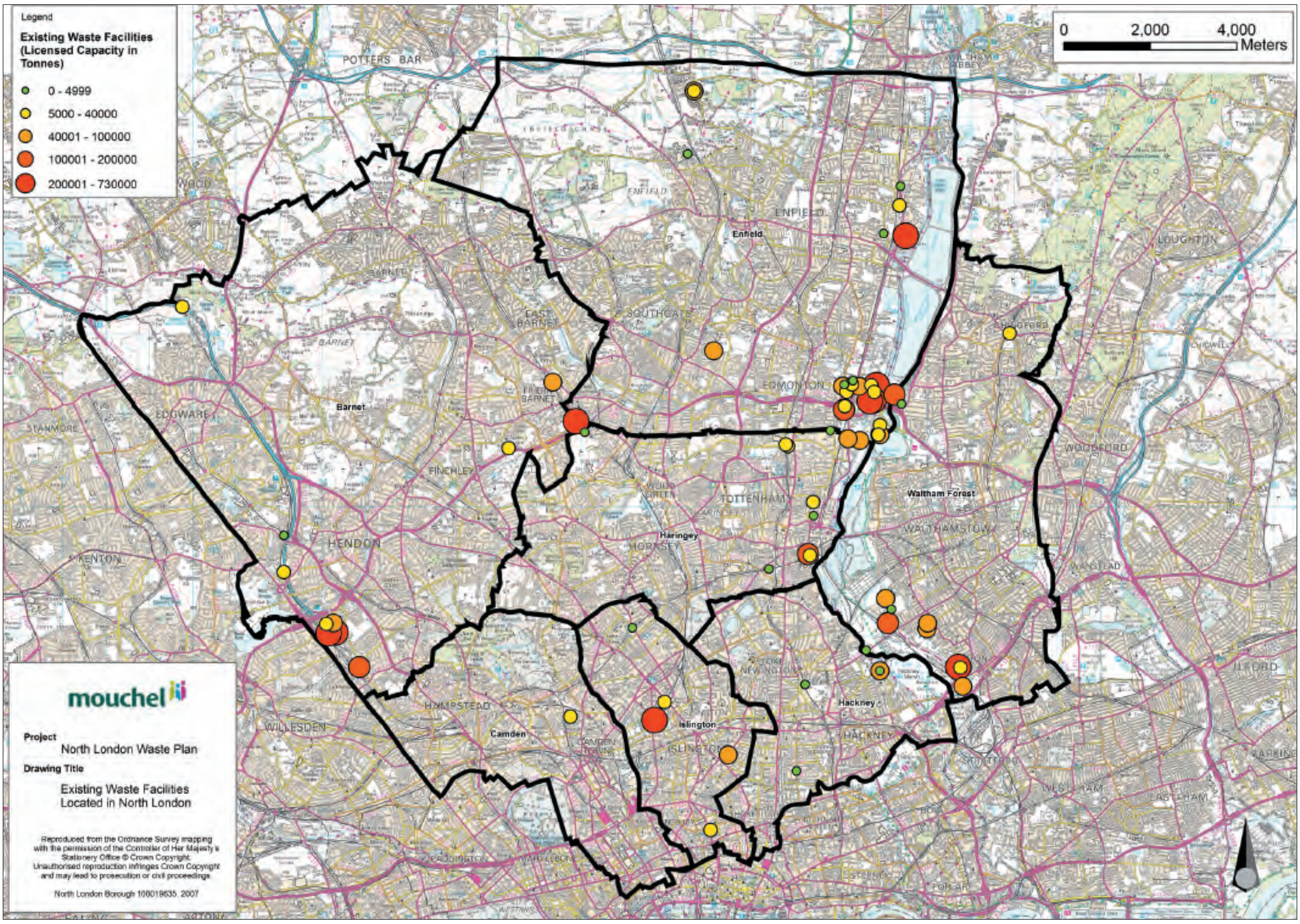

Figure 1: Existing waste facilities in North London

Need to integrate LCA with spatial analysis: the North London Waste Plan (NLWP):
LCA has been used to support the definition of the UK national WM policies (4). However, testing with several case studies has highlighted that when LCA is used as a standalone tool, it can not provide a comprehensive answer to the multiple concerns raised at a local level (5). Moreover, to achieve the objectives set out by the NLWJS, the number and type of facilities will have to increase, both for recycling and treatment of the municipal solid waste. These observations underline the usefulness of designing a methodology to integrate the LCA with a spatial analysis.

The seven North London Boroughs are currently engaged, as planning authorities, in drawing up a planning framework for the siting of waste facilities in their area (6). The NLWP will consider all waste streams, not just municipal solid waste, and needs to identify sufficient land across the area to handle the amount of waste projected for 2020. The Plan is being drawn up to be in conformity with national and regional guidelines but also with the boroughs' other plans and strategies. The Plan has to balance the need for waste facilities with other needs, such as for housing, employment and environmental improvement. As a land-use plan, the NLWP must engage in public consultation at the various stages of the plan and take on board views expressed at these times. A long list of possible waste sites is being whittled down by using both constraint and opportunity based criteria along with the results of various assessments. A number of site options for meeting waste targets can then be tested and a preferred option will be consulted upon.

Why is the NLWA a relevant case study
The characteristics of the areas served by the NLWA, the timing of the planning efforts and the quality of the planning documents produced, make this case study particularly relevant to the definition of a comprehensive methodology for assessing and selecting WM strategies.

The environmental impact induced by the increase and diversification of the infrastructural framework required by the challenge to strongly and rapidly innovate WM has to be fully considered and accounted for. The appropriate location of the several plants and facilities required is pivotal, if efficient high material recovery and distribution of energy are to be achieved. The quality of air emissions, the amount of land required and the transportation loads are also relevant elements for the comparison of different WM scenarios in terms of their connection with the local environment actually affected by the implementation.

These are just a few of the parameters that must be considered when comparing different WM scenarios, but a comprehensive evaluation also demands the integration of strategic land planning into the WM design. It is underlined that, given citizens' health and environmental concerns with respect to local WM strategy outcomes, the study of the urban organisation and of possible alternative locations becomes a tool for the integration of these needs into the LCA accounting.

References

1 EC JRC "Environmental Assessment of municipal waste management scenarios: II – Detailed Life Cycle Assessment, EUR 23021 EN/2 -2007.

2 Yassin L, Lettieri P, Simons SJR, Germana' A, 2005, Energy recovery from thermal processing of waste: a review. Engineering Sustainability Journal, 158, Issue ES2, 97-103.

3 NLWA documents can be downloaded at http://www.nlondon-waste.gov.uk/html/jointwastestrategy.asp

4 ERM, Golder Associates "Carbon Balances and Energy Impacts of the Management of UK Wastes", December 2006

5 D. Longden, "Distributed or centralised EfW policy? Implications of technology and scale at municipal level", Energy Policy, 35, 2007, 2622.

6 the NLW Plan can be downloaded at http://www.nlwp.net/

Intellectual Property Rights in Traditional Knowledge

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In the May 2008 issue of the *Chemical Hazards and Poisons Report*, Dr. Robert Maynard presented an interesting article[1] exploring the changing attitude towards herbal medicine in which he points out that it is "generally accepted that Western pharmacology and therapeutics grew from herbal medicine". Herbal medicine is part of the ancient wisdom on the use of natural resources and the question arises whether this knowledge is freely available for use and – in many cases – commercial exploitation. It is therefore not only the medical profession that is taking a closer look at the issues surrounding the use of natural ingredients in the modern world. Lawyers and non-governmental organisations have for a number of years discussed the issues relating to Traditional Knowledge (TK) and the intellectual property rights vested therein. Herbal medicine is an important element of TK and it is relevant to consider whether there is reason to establish a legal protection for TK and how such protection can be maintained.

The need for protection

It has always been recognised that TK is of significant spiritual and utilitarian importance to indigenous peoples but it has only more recently become clear that TK may have considerable commercial value and that there is a need to ensure a level of protection for the original knowledge holders. This has, to some extent, clashed with the conventional view of the developed world, which has generally regarded TK as information in the public domain.

There are a number of reasons why protection of TK is important but the debate has focused mainly on ways to obtain a fair distribution of the benefits of TK and to prevent the TK owners' own product markets from being subjected to unfair competition by unoriginal imitations. It has been suggested that traditional intellectual property right models are reasonably sufficient to protect certain elements of TK but that it, in other respects, may be necessary to go beyond the recognised legal approaches and use alternative protection and compensatory models.

Definitions

One of the major difficulties in defining and protecting TK from a legal point of view is that it spans across a variety of fields, ranging from scientific knowledge in the fields of medicine, plant genetic resources, crafts etc. to cultural activities including folklore, folk music, performances and other related art forms. It is difficult to cover TK by a single definition but the World Intellectual Property Organisation (WIPO) has broadly characterized it as "the ideas and expressions thereof developed by traditional communities and Indigenous peoples, in a traditional and informal way, as a response to the needs imposed by their physical and cultural environments and that serve as means for their cultural identification"[2].

Protection

The main reasons[3] suggested for establishing a system of legal protection for TK include the conservation and preservation of traditional practices and culture, the prevention of unauthorised appropriation by third parties and the promotion of TK as a source of income generation for the original knowledge holders. These goals may not all be obtainable through the same methods and the form of legal protection must necessarily be dictated by the purpose and the subject matter of the protection.

The relevant forms of protection can, broadly speaking, be classified as "defensive protection" and "positive protection".

Defensive protection is mainly aimed at preventing misappropriation or unauthorised use of TK and TK based products by third parties outside of the indigenous communities. The purpose of defensive protection is therefore protection, preservation and conservation rather than the exploitation and the assertion of Intellectual property rights. One way of achieving defensive protection would be through the registration of TK in databases which would serve to establish the presence of TK in the public domain and act as a notice to patent examiners in their search for prior art. There are, however, justified concerns that such databases, in some respects, would have an undermining effect on certain rights and the registration should be limited to TK which is unquestionably in the public domain and which is not by its original holders considered sacred, valuable, secret, technologically or commercially significant, or otherwise inappropriate for general publication[4].

Along the same lines, WIPO has also suggested[5] that patent examiners who work in certain technical fields including life sciences and environmental technology should be given training and awareness in TK and TK systems.

In a recent (April 2008) address to the Asia Pacific Jurist Association, the Chief Justice of India, K G Balakrishnan, has proposed the creation of an Indian registry of TK and a national body representing the communities concerned, together with the adoption of a legal scheme which would allow a community to offer traditional knowledge for public use and receive equitable remuneration or benefits in case of private commercial use.

Positive protection would empower the TK holders to actively assert their rights in the protected subject matter and give them the right to refuse access or to authorise and determine the terms for access by third parties. This could be achieved, either through the protection of TK under a traditional, "Western" style intellectual property regime or through sui generis regimes developed particularly with the protection of TK in mind.

The positive protection model has been extensively discussed and explored and it is clear that many forms of TK could potentially be well protected under the existing (traditional) modes of intellectual property protection including not only patent rights, copyright, design rights and trademark rights but also appellations of origin and plant breeders' rights.

It is, on the other hand, also clear that the very nature of TK presents some serious obstacles to protecting TK through such traditional intellectual property right systems. The holders of TK are often communities rather than individuals and there are obvious difficulties connected with identifying the beneficiaries of a registration. In relation to patent law it may be doubtful if inventions in the field of herbal medicinal products can meet the requirements for patentability in form of novelty and inventive step. Herbal medicines are not necessarily old – contrary to some popular belief, they are constantly developing and improving – nor are they necessarily in the public domain but they may have developed over a period of time and may have been discovered or circulated in parallel in several different communities. Even where such issues do not arise, the TK holders would face the obstacles of formulating their knowledge for registration (where registration is required), of the costs of registration and, most importantly, of the costs and other difficulties connected with the enforcements of their rights.

A third approach which has been widely debated is the establishment of one or more *sui generis* regime(s) especially designed with the nature of TK in mind. It has been discussed whether such system(s) would be most useful if developed on a national or on an international scale and whether the best model would be a single regime covering all kinds of TK or a set of individual regimes each covering a different type of TK.

A number of such systems are already in existence on a national scale in various parts of the world. The key elements of a *sui generis* regime will be to define the subject matter of and the criteria for protection and the extent and ownership of the protected rights, but it is also important that the system is developed in such a way that it does not attempt to meet too many objectives or protect too many interests and it has been suggested[6] that existing *sui generis* systems are analysed as a part of the process of designing more general systems for wider use.

One existing *sui generis* system has been established in Thailand under the "Thai Traditional Thai Medicinal Intelligence Act" which distinguishes between three different types of formulations:

National Formulae are formulations of significant importance to human health which belong to the State and which can be used commercially and for Research and Development only after permission from the Thai government. *Private Formulae* are protected through registration which grants an exclusive right subsisting throughout the life of the owner and for a further period of 50 years. *General Formulae* are the commonly known formulae which are free to use for everybody. An important element of the Act is that all three types of *formulae* can be freely used by traditional healers in limited quantities[3]. The Act is a good example of how the various issues can be addressed at a national level by combining elements of traditional intellectual property protection with protection and compensation measures more specifically designed for TK.

The most recent proposal to establish a national system for the protection of TK comes from China where it is estimated that 50% of the internal market for pharmaceutical products is covered by traditional Chinese medicine. In a new national strategy for intellectual property rights[7] it is proposed to establish a system to support the collation, passing down and protection of TK to further its development. It is specifically recommended that an improved coordination mechanism is established for the administration, protection and utilisation of the intellectual property rights in traditional medicine. The strategy as a whole indicates that China expects to become a major player in the field of intellectual property rights and it sends out the welcome signal that the Chinese government intends to take such rights very seriously in the future.

A final element in achieving protection for TK, whether through a system based on traditional intellectual property rights or through a *sui generis* model, is the ability of such system to respect the framework of customary laws and practices of the local communities in which it is intended to operate[8]. Just as Western pharmacology has its roots in herbal medicine, legal systems are derived from customs and practices and customary law plays an important role in the life of indigenous peoples. Customary law will in many cases be inalienable from the identity and integrity of the people and the communities whose rights it is the intention to protect and the application of customary law may therefore in itself be an important contributory factor to the effectiveness of any sui generis regime.

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References

1. **Chemical Hazards and Poisons Report, Herbal medicines - changing attitudes, May 2008**
2. **WIPO, Composite Study on the Protection of Traditional Knowledge, July 7 to 15, 2003**
3. **Carlos M Correa, Traditional Knowledge and Intellectual Property, Quaker United Nations Office, November 2001**
4. **WIPO, Elements of a *sui generis* system for the protection of traditional knowledge, December 9 to 17, 2002**
5. **WIPO, Recognition of traditional knowledge within the patent system, February 25 to 29, 2008**
6. **Krishna Ravi Srinivas, Asian Journal of WTO & International Health Law and Policy, March 2008., p. 107**
7. **State Council of the People's Republic of China, Outline of National Intellectual Property Strategy, June 2008**
8. **Center for International Environmental Law, The gap between indigenous peoples' demands and WIPO's framework on traditional knowledge, September 2007**

Containment landfill sites – how to restore to beneficial land-use without compromising pollution control systems

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Introduction

Landfill gas is produced by biological activity in landfills which contain sufficient putrescible material to cause methane generation. It usually contains 40 to 65% methane, a gas which is equivalent to 21 times the amount of Carbon Dioxide (CO_2) in its global warming potential. Trace gases include hydrogen sulphide, chloroethene (vinyl chloride), carbon disulphide and the BTEX (benzene, toluene, ethylbenzene and xylene) group of compounds. Landfill gas can cause asphyxiation, nausea and intoxication. It also presents risk of local environmental damage when it migrates from the landfill into the soil and damages or kills vegetation established on it. There is also a danger of explosion through the formation of methane-air mixtures, within the explosive limits of methane (5 to 15 % by volume of methane in air). Fire is an additional risk.

Landfill leachate is potentially more hazardous to health. Leachate is the product of waters moving through landfill wastes and is composed of soluble compounds, some oils and lipids, and suspended solids. Leachates can contain high concentrations of soluble degradable organic compounds, ammonium and metals. Environmental hazard occurs when landfill leachates escape into surrounding soils, sediments, rocks, and surface and groundwaters.

The Landfill (England and Wales) Regulations 2002 make provision to reduce the risk of landfill gas and leachate to acceptable and manageable levels. Modern landfills require wastes to be contained within 'tombs' surrounded by relatively impermeable base, sides and cap, usually constructed of compacted clay, with or without additional layers of artificial barrier materials. Pollution control is dependent on the integrity of these gas and leachate barriers over the lifetime of the landfill, and then for the foreseeable future.

Landfill restoration

There are estimated to be about 1500 landfills in the UK (in 2005), covering an area of around 28000 ha. Many of these occur in peri-urban areas. Pollution control is therefore a vital issue in the engineering and post closure management of these sites. However, the appearance and function of these sites after landfilling is completed are also important considerations. Planning Policy Statement 23 '*Planning and Pollution Control*' (2004) makes it clear that 'planning and pollution control systems are separate but complementary'. Hence, the after-use of land previously used for landfilling must help to mitigate, not encourage, pollution risk, whilst also helping to bring the land back to beneficial use. Minerals Policy Statement 1 '*Planning and Minerals*' (2006) suggests that those responsible for restoration should 'take account of the opportunities for enhancing the overall quality of the environment and the wider benefits that sites may offer, including nature...conservation and increased public accessibility, which may be achieved by sensitive design' and to 'consider the opportunities that sites may offer for the development of new woodland areas and for providing networks of habitats'.

Landfill to woodland?

In fact, earlier guidance on landfill reclamation, such as 'Landfilling Wastes'[1], considered the risk of trees damaging the landfill cap too large and effectively dissuaded their planting on such sites. Tree roots were considered as likely to penetrate into the landfill cap and thus increase its permeability. Trees, themselves, were considered to be at risk of windthrow, whereupon the mineral cap might be exposed to further risk of degradation. Furthermore, the harsh conditions presented at many landfill sites were thought to make trees unlikely to thrive anyway.

Nevertheless, in 1992 the (then) Department of the Environment funded Forest Research to examine whether trees and woodland could be established on containment landfills. After a research campaign of nearly fifteen years, the latest report has just been published by the Department for Communities and Local Government (DCLG). (http://www.communities.gov.uk/documents/planningandbuilding/pdf/825167.pdf).

The combined evidence now suggests that landfills should and can be restored to beneficial after-use and that with due regard for engineering structures, trees can form part of the design.

One important research strand was to establish a range of tree species on five modern restored landfills across England in 1993/4, and to monitor their performance. Figure 1 shows the results of ten years growth. Survival varied between species and sites, with poor survival the result of drought, browsing by deer or general unsuitability to site conditions. However, survival rates and tree growth were for the most part satisfactory to good (see Figure 2), and comparable with those found on greenfield sites in the localities of the experimental sites. This research has shown that whilst inappropriate species can indeed fail on landfill sites, there are reasonable expectations for good growth and the establishment of a woodland cover – where sufficient soil materials are provided in which to anchor the trees and to provide water and nutrients. Both native and non native species can be established, with poplar, alder, cherry, whitebeam and ash performing best. These and other species should give flexibility to meet a range of woodland objectives from enhancing landscape or habitat creation to meeting demands for biomass for renewable energy. At no site has any evidence of landfill gas escape been detected that might be due to tree roots penetrating the landfill cap. Nevertheless the experiments are comparatively young, and were set up to study tree root behaviour at the soil/cap interface sometime in the future.

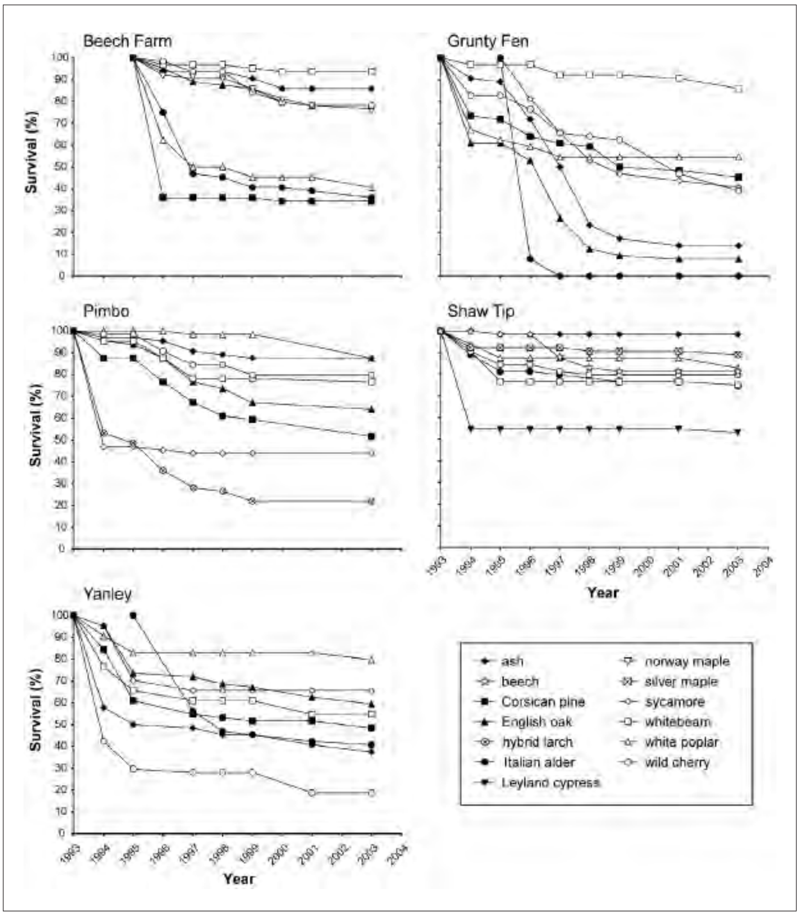

Figure 1: Tree survival for tree species at the five landfills since planting

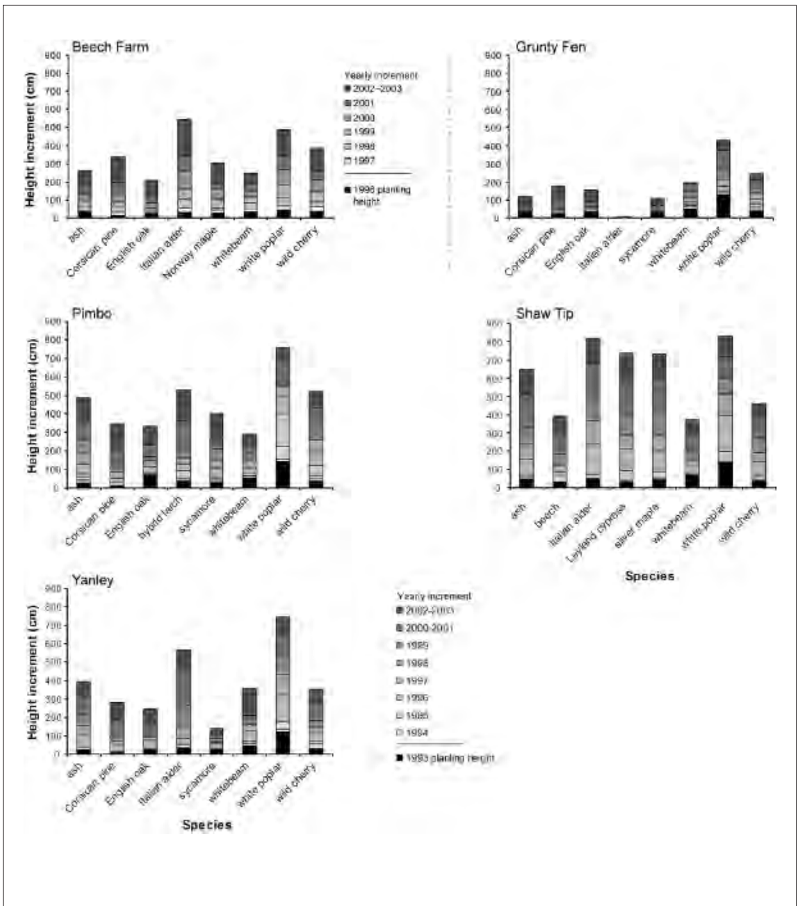

Figure 2: Yearly height growth for tree species at the five landfill sites since planting

Another important issue to address was whether tree roots would penetrate into landfill mineral caps and thus, threaten their integrity by providing preferential pathways for water ingress and gas emission. A review of the literature[2] in the early 1990s suggested that tree roots could not penetrate a well-engineered cap designed to meet legal permeability requirements. However, it was decided to test this by studying the actual rooting habits of four tree species that had been established on a containment landfill in 1986. This site had been restored with soil placed in a large ridge and furrow landform over the mineral cap, which permitted the study of the effect of soil thickness on tree root habit. In 2002, 41 trees were excavated and their root systems meticulously recorded and analysed. Figure 3 shows some examples of root distributions. For the most part, roots did not penetrate the cap, but root penetration did occur, especially if the soil cover was relatively thin. Nevertheless, only 6.3% of total sycamore root count, 2.4% of total alder root count, 1.8% of total ash root count and 0.4% of total Corsican pine root count entered into the cap, irrespective of soil thickness. Of the seven trees planted in at least 120 cm of soil, only two had roots that reached the cap and only the roots of one of those trees penetrated the cap.

The root results were modelled to examine the likely degree of penetration with soil thickness over the cap. The model shows that there is an approximately exponential decline in the total number of roots per tree penetrating into the cap as the depth of the soil cover increases (see Figure 4). The confidence interval (CI) for the model is very large at shallow soil depths, but is much smaller for thicker soil covers over the cap. At a cap depth of 1.25 metres, only one root per tree was predicted to penetrate into the cap, and the model suggests that this will rarely be above three roots (95% confidence). The results strongly support other findings[2,3,4] that the placement of a thick soil cover over the landfill cap will minimise the degree of root penetration into it, and the model supports the earlier contention that a thickness of 1.5 m will reduce the risk of root penetration to almost zero. Micromorphological studies[5] also identified that where root penetration occurred, it did so in zones of weakness in the mineral cap where bulk density was below that required to achieve the required permeability (1.0×10^{-9} m s^{-1}).

Conclusions

Taken together, our studies suggest that earlier fears about the position of trees on landfills are largely unfounded. With appropriate engineering to meet landfill cap permeability requirements and the provision of a suitable (c. 1. 5 m) thickness of soil or soil-forming materials, appropriately chosen tree species do not appear to threaten pollution control measures. Instead, the resulting tree or woodland cover can be considered, in itself, as a valuable sink for atmospheric pollutants, particularly particulates[6]. Thus, appropriately designed woodland should be seen as supporting both regulatory and planning aspirations. Further information on the place of trees on landfill sites, or as part of a greening solution in brownfield remediation and restoration can be obtained from the authors.

Acknowledgements

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References

1 Department of the Environment 1986. Landfilling Wastes. Waste Management Paper No. 26. HMSO, London.

2 Dobson, M.C. and Moffat, A.J. 1993. The potential for woodland establishment on landfill sites. HMSO, London.

3 Hutchings, T.R., Moffat, A.J. and Kemp, R.A. 2001. Effects of rooting and tree growth of selected woodland species on cap integrity in a clay capped landfill site. Waste Management and Research 19, 193-200.

4 Hutchings, T.R., Sinnett, D., Peace, A. and Moffat, A.J. 2006. The effect of woodland growth on a containment landfill site in Hertfordshire, UK. Urban Forestry and Urban Greening 5, 169-176.

5 Mooney, S.J., Foot, K., Hutchings, T.R. and Moffat, A.J. 2007. Micromorphological investigations into root penetration in a landfill mineral cap, Hertfordshire, UK. Waste Management 27, 1225-1232.

6 Freer-Smith, P.H., Beckett, K.P. and Taylor, G. 2005. Deposition velocities to Sorbus aria, Acer campestre, Populus deltoides x trichocarpa 'Beaupré', Pinus nigra and x Cupressocyparis leylandii for coarse, fine and ultra-fine particles in the urban environment. Environmental Pollution 133(1), 157–168.

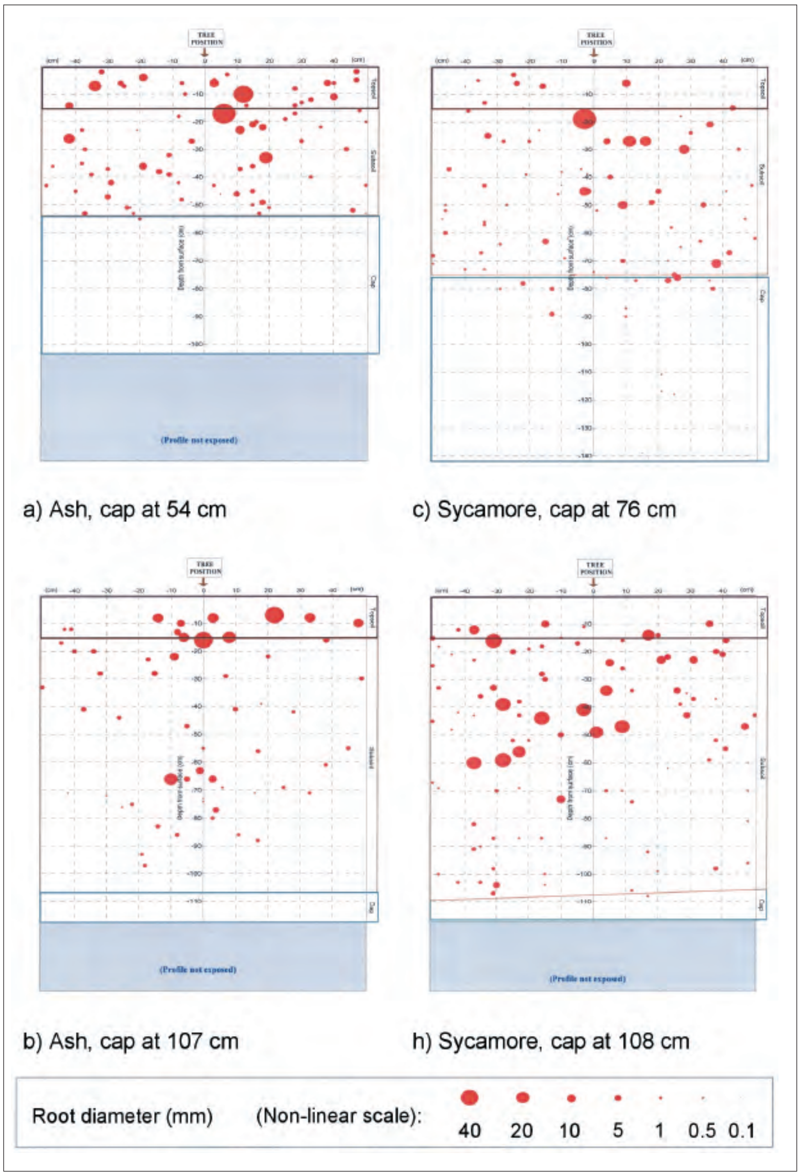

Figure 3: Examples of tree root distributions relative to cap depth

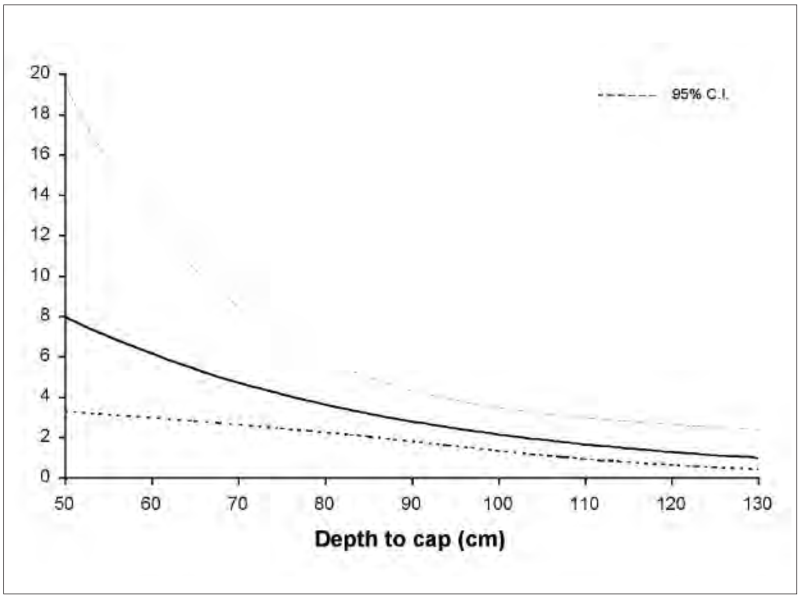

Figure 4: Modelled relationship between soil thickness over cap and degree of tree root penetration (C.I. = confidence interval)

Natural disasters and climate change

The International Strategy for Disaster Reduction and its Hyogo Framework for Action (2005-2015): Building the Resilience of Nations and Communities to Disasters

Salvano Briceno and Paula Albrito, United Nations International Strategy for Disaster Reduction

Introduction

In 1999, the United Nations General Assembly agreed on the successor arrangements to the International Decade for Natural Disaster Reduction.[1] The United Nations International Strategy for Disaster Reduction (UN/ISDR) was started and is a system of partnerships with the overall objective of generating and supporting a global disaster risk reduction movement to reduce risk to disasters.[2] ISDR partners are governments, United Nations systems, regional bodies, international financial institutions and non-governmental actors. The ISDR system mechanisms include

- Global Platform for Disaster Risk Reduction [3]
- National[4], Regional[4] and Thematic Platforms[5]
- ISDR Support Group[6]
- ISDR Management Oversight Board
- ISDR Inter-Agency Group
- ISDR Scientific and Technical Committee[7]
- the ISDR secretariat (UN/ISDR).

These mechanisms link together as illustrated in figure 1:

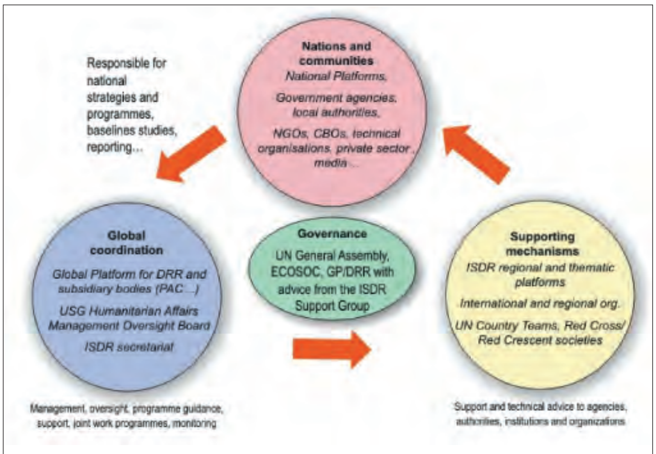

Figure 1: The main elements of the strengthened ISDR System in support of the Hyogo Framework for Action[8]

Building the resilience of nations and communities to Disasters by 2015 (the Hyogo Framework)

The second World Conference on Disaster Reduction was held from 18 to 22 January 2005 in Kobe, Hyogo, Japan, and adopted the present Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters (here after referred to as the "Framework for Action"). The Conference provided a unique opportunity to promote a strategic and systematic approach to:

- Reducing vulnerabilities (where vulnerability is defined as the conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards)[9]

- Risks to hazards (where a hazard is defined as a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.) Hazards can include latent conditions that may represent future threats and can have different origins: natural - geological, hydro-meteorological and biological – or those induced by human processes - environmental degradation and technological hazards[9]

It underscored the need for, and identified ways of, building the resilience of nations and communities to disasters. Two summary tables of the Hyogo Framework were prepared and provide diagrammatic approaches to:

- Expected outcomes, strategic goals, and priorities for action 2005-2015 and includes expected outcomes, strategic goals, priorities for action and cross cutting issues (figure 2)

- Implementation and follow up with general considerations, an identification of the actors in States, Regional Organisations and Institutions and international organisations, how they relate to ISDR, and resource mobilization (figure 3)

The Hyogo Framework for Action was adopted by 168 governments in January 2005 in the aftermath of the Indian Ocean Tsunami. It provides policy guidance on disaster risk reduction and is an essential instrument for adaptation to climate change. Together with the World Health Organization, the UN/ISDR promotes that safety of hospitals and health care facilities are given a higher priority by governments in order to avoid increasing the magnitude of disasters when hazards strike.

Furthermore, as the scale of disasters increase due to rapidly expanding vulnerability in urban settings, in particular in coastal areas - exacerbated by environmental degradation and climate change - it is urgent to make disaster risk reduction a higher priority in policies in both public and private sector, including public awareness campaigns for every citizen to reduce risk and vulnerability in their daily lives.

Figure 2. Summary of the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters (Hyogo Framework)

Expected outcome, strategic goals and priorities for action 2005-2015

Expected Outcome

The substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries

Strategic Goals

- The integration of disaster risk reduction into sustainable development policies and planning
- Development and strengthening of institutions, mechanisms and capacities to build resilience to hazards
- The systematic incorporation of risk reduction approaches into the implementation of emergency preparedness, response and recovery programmes

Priorities for Action

1. Ensure that disaster risk reduction (DRR) is a national and a local priority with a strong institutional basis for implementation

Key Activities:
- DRR institutional mechanisms (national platforms); designated responsibilities
- DRR part of development policies and planning, sector wise and multisector
- Legislation to support DRR
- Decentralisation of responsibilities and resources
- Assessment of human resources and capacities
- Foster political commitment
- Community participation

2. Identify, assess and monitor disaster risks and enhance early warning

Key Activities:
- Risk assessments and maps, multi-risk: elaboration and dissemination
- Indicators on DRR and vulnerability
- Data & statistical loss information
- Early warning: people centered; information systems; public policy
- Scientific and technological development; data sharing, space-based earth observation, climate modeling and forecasting; early warning
- Regional and emerging risks

3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels

Key Activities:
- Information sharing and cooperation;
- Networks across disciplines and regions; dialogue
- Use of standard DRR terminology
- Inclusion of DRR into school curricula, formal and informal education
- Training and learning on DRR: community level, local authorities, targeted sectors, equal access
- Research capacity: multi-risk; socio-economic; application
- Public awareness and media

4. Reduce the underlying risk factors

Key Activities:
- Sustainable ecosystems and environmental management
- DRR strategies integrated with climate change adaptation
- Food security for resilience
- DRR integrated into health sector and safe hospitals
- Protection of critical public facilities
- Recovery schemes and social safety- nets
- Vulnerability reduction with diversified income options
- Financial risk-sharing mechanisms
- Public-private partnership
- Land use planning and building codes
- Rural development plans and DRR

5. Strengthen disaster preparedness for effective response at all levels

Key Activities:
- Disaster management capacities: policy, technical and institutional capacities
- Dialogue, coordination & information exchange between disaster managers and development sectors
- Regional approaches to disaster response, with risk reduction focus
- Review & and exercise preparedness and contingency plans
- Emergency funds
- Voluntarism & participation

Cross Cutting Issues

- Multi-hazard approach
- Gender perspective and cultural diversity
- Community and volunteers participation
- Capacity building & technology transfer

Contributing to the achievements of the internationally agreed development goals (including the MDGs)

Implementation and Follow-Up

In order to achieve the goals and act upon the priorities identified in this Framework, the following tasks have been identified to ensure implementation and follow-up by States, regional and international organizations in collaboration with civil society and other stakeholders. The ISDR partners, in particular the Inter-agency Task Force on Disaster Reduction and secretariat, are requested to assist in implementing this Framework for Action.

General Considerations

- Implementation by different stakeholders, multi-sectoral approach; participation of civil society (NGOs, CBOs, volunteers), scientific community & private sector is vital
- States primarily responsible; an enabling international environment is vital, incl. strengthened regional capacities
- Build multi-stakeholder partnerships
- Particular attention to:
  - Small island developing States: Mauritius Strategy;
  - Least developed countries;
  - Africa
- States, regional and international organizations to foster coordination among themselves and a strengthened International Strategy for Disaster Reduction (ISDR)
- Follow-up integrated with other major conferences in fields relevant to DRR; reviews as appropriate

Actors

Critical tasks:

States
- Designate national coordination mechanisms for the implementation and follow up, communicate to the ISDR secretariat;
- National baseline assessments of the status of DRR;
- Publish and update a summary of national programme for DRR including international cooperation;
- Develop procedure for reviewing national progress including systems for cost benefit analysis and ongoing monitoring on risk;
- Consider acceding to, approving or ratifying relevant international legal instruments and to make sure they are implemented;
- Promote the integration of DRR with climate variability and climate change into DRR strategies and adaptation to climate change; ensure management of risks to geological hazards.

Regional Organizations and Institutions
- Promote regional programmes including for technical cooperation, capacity development, the development of methodologies and standards for hazard and vulnerability monitoring and assessment, the sharing of information and effective mobilization of resources;
- Undertake and publish regional and sub-regional baseline assessments;
- Coordinate and publish reviews on progress and support needs, and assists countries in preparation of national summaries;
- Establish specialized regional collaborative centers;
- Support the development of regional mechanisms and capacities for early warning, including for tsunami

International Organizations (including UN System and IFIs)
- Engage in the implementation of the ISDR by encouraging integration of DRR into humanitarian and sustainable development fields;
- Strengthen the capacity of the UN system to assist disaster-prone developing countries in DRR and implement measures for assessment of progress;
- Identify actions to assist disaster-prone developing countries in the implementation of the Hyogo Framework, ensure their integration and that adequate funding is allocated; assist in setting up national strategies and programmes for DRR;
- Integrate actions into relevant coordination mechanisms (UNDG, IASC, RCs and UN Country Teams);
- Integrate DRR into development assistance frameworks such as CCA/UNDAF, PRSP;
- In collaboration with networks and platform support: data collection and forecasting on natural hazards and risks; early warning systems; full & open exchange of data;
- Support States with coordinated international relief assistance, to reduce vulnerability & increase capacities;
- Strengthen international mechanisms to support disaster stricken States in post-disaster recovery with DRR approach
- Adapt & strengthen inter-agency disaster management training for DRR and capacity building.

ISDR (Inter-Agency Task Force on Disaster Reduction & secretariat)

- Develop a matrix of roles and initiatives in support of follow/up to the Hyogo Framework;
- Facilitate the coordination of effective actions within the UN system and other international and regional entities to support the implementation of the Hyogo Framework, identify gaps, facilitate processes to develop guidelines and policy tools for each priority area;
- In broad consultation, develop generic, realistic and measurable indicators. These indicators could assist States in measuring progress in the implementation of the Hyogo Framework;
- Support national platforms & regional coordination;
- Register relevant partnerships with Commission on Sustainable Development;
- Stimulate the exchange, compilation, analysis and dissemination of best practices, lessons learnt;
- Prepare periodic review on progress towards achieving the objectives of the Hyogo Framework and provide reports to the UNGA & other UN bodies

Resource Mobilization: States, Regional and International Organizations

- Mobilize resources and capabilities of relevant national, regional and international bodies, including the UN system;
- Provide and support the implementation of the HFA in disaster prone developing countries, including through financial and technical assistance, addressing debt sustainability, technology transfer, public-private partnership and North-South and South-South cooperation;
- Mainstream DRR measures into multilateral and bilateral development assistance programmes;
- Provide adequate voluntary financial contribution to the UN Trust Fund for DR to support follow-up activities to Hyogo Framework; review usage and feasibility for the expansion of this fund;
- Develop partnership to implement schemes that spread out risks, reduce insurance premiums, expand insurance coverage and increase financing for post-disaster reconstruction, including through public and private partnerships. Promote an environment that encourages a culture of insurance in developing countries.

References

1 UNITED NATIONS General Assembly. Resolution adopted by the General Assembly [*on the report of the Second Committee* (A/54/588/Add.2)]54/219. International Decade for Natural Disaster Reduction: successor Arrangements A/RES/54/219 3 February 2000

http://www.unisdr.org/eng/about_isdr/basic_docs/GA-resolution/a-res-54-219-eng.pdf (accessed 07.07.08)

2 International Strategy Disaster Reduction (ISDR) ISDR system http://www.preventionweb.net/english/hyogo/isdr/ (accessed 06.07.08)

3 International Strategy Disaster Reduction (ISDR) Global Platform for Disaster Risk Reduction

http://www.preventionweb.net/english/hyogo/GP/ (accessed 07.07.08)

4 International Strategy Disaster Reduction (ISDR) The Strengthened ISDR System Institutional Arrangements & Roles and Responsibilities July 2006 #585,7,ISDR system Levels of Action ("platforms")

http://www.unisdr.org/eng/isdr-system/docs/ecosoc-mws-13july.ppt (accessed 07.07.08)

5 International Strategy Disaster Reduction (ISDR).Thematic Cluster / Platform on Knowledge and Education.

http://www.unisdr.org/eng/partner-netw/knowledge-education/knowledge-education.htm (accessed 06.07.08)

6 International Strategy Disaster Reduction. ISDR support group workspace. http://www.preventionweb.net/english/professional/networks/private/support-group/ (accessed 07.07.08)

7 International Strategy Disaster Reduction (ISDR). Inter-Agency Task Force On Disaster Reduction Establishment of an Advisory Scientific and Technical Group for the ISDR Doc. # TF3/3, Third Meeting, Geneva, 3-4 May 2001

http://www.unisdr.org/eng/task%20force/tf-meetigns/3rd%20TF%20mtg/TF-3_focus_paper_Advisory_Group.doc (accessed 07.07.08)

8 International Strategy Disaster Reduction (ISDR). In a nutshell. http://www.unisdr.org/eng/isdr-system/In-a-nutshell.htm (accessed 07.07.08)

9 Living with Risk: A global review of disaster reduction initiatives. UN/ISDR Geneva, 2004

MONTSERRAT: A Tale of the Islands

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Introduction

Montserrat! The name, first given to the island by Christopher Columbus in 1493, conjures up an image of a Caribbean island set in a turquoise sea – white beaches, palm trees, verdant mountains and tropical rainforest, with a history of buccaneers. Sadly, the island today is a very different place from when the distinguished surgeon, Sir Frederick Treves, described it in 1908 (Treves, 1908). Treves spoke of "The beautiful and healthy island of Montserrat". Recent volcanic activity has rendered the island uninhabitable and ugly in its southern part. The main town of Plymouth lies buried in ash like a latter day Pompeii and more than half the original population of 13,000 had to leave as the threat from the volcano grew, with many taking up an assisted passage scheme in 1997-8 to live in the UK.

The eruption of the Soufrière Hills volcano began in 1995 and those who stayed behind live in the north of the island and wait, disbelieving, as the volcano shows no sign of letting up. Attempts to reoccupy the less hazardous parts of the south are prevented as the eruptive cycle slowly repeats itself: lava, gradually building up in the crater to form a large dome which eventually collapses, tumbles down the volcano's flanks forming deadly pyroclastic flows and blankets of ash over the landscape. The powdery grey ash, as fine as talcum powder, kills vegetation and, blown by the steady Trade Winds, rises in clouds that pose a risk to health. Houses lie abandoned.

Figure 1: Damage and dust caused by Soufrière Hills volcano, Montserrat, March 2008 (Image courtesy of Dr. Sarah Petrie, Department for International Development (DfID))

The island is only 17 km long and 9 km wide and the volcano lies in its southern part. Montserrat acquired its first British Governor in 1625 – under a royal patent from Charles I. In 1632, Irish Catholics settled on the island and the association with Ireland began. Montserrat is the "other" Emerald Island. In the 18th century, slaves were transported to the island to work in the, then, flourishing sugar plantations. The island lies in the Lesser Antilles close to Antigua and Guadeloupe in an arc of volcanic islands stretching from Anguilla in the north to Grenada in the south. Montserrat became a Crown Colony in 1866 and is today an Overseas Territory, along with other islands, including The Falklands and St Helena.

The Crisis

On July 18 1995, the Soufrière Hills volcano moved from a semi-dormant to a dangerously active state, marked by a steam plume and light falls of ash. The islanders waited in trepidation. On August 21, a ground-hugging ash cloud swept over Plymouth, an experience so frightening that people self-evacuated to the north of the island where they stayed for two weeks before feeling it was safe to return to their homes. At the end of November, the old summit crater started to slowly fill with lava and emit a strong gas plume: Plymouth had to be evacuated again for over a month as a precaution against a potential massive explosion.

By April 1996, the lava dome had grown so large that the first pyroclastic flows began and the people of Plymouth and some villages close to the volcano were then permanently relocated. The first explosive eruption on September 17th marked the beginning of more serious activity and thereafter, ash falls and pyroclastic flows became more frequent as the dome growth became relentless. The climax of the crisis occurred on June 25th, with a massive dome collapse that formed the largest pyroclastic flows of the eruption which struck out towards the airport and the Central Belham Valley area, destroying villages and houses. Nineteen people who had gone back to their homes against all official advice were killed instantly in the searing hot flow. Several others were badly burned and had to be flown with a French emergency team by helicopter to hospital in nearby Guadeloupe. One of the authors (Peter Baxter) was on the island at the time studying the volcano and played a key role in providing medical advice. By August, many more people had moved to the north and increasing numbers were leaving the island.

In September 1997, the then UK Chief Medical Officer, Sir Kenneth Calman, took a team to the island: the team included Peter Baxter and Robert Maynard. This was a desperate time: ash falls, explosive events and fear that was tangible. Scientists conducted a volcanic risk assessment in December to advise UK Ministers on the safety of people living in the northern half of the island. The UK and Montserrat governments accepted their advice that the island did not need to be completely evacuated.

While no further deaths have occurred since June 1997, the risks to health posed by inhalation of ash from the frequent ash falls and subsequent re-suspension of fine ash by winds, traffic, and all kinds of human activity have become a matter of great concern. The central and northern parts of the island remain beautiful with regular rainfall promoting the growth of grass and other vegetation on accumulated deposits of ash, and keeping roads and trees washed clean. After heavy ash falls, crews rapidly remove the ash from the roads to reduce one important source of exposure. Life in the north for the 4000 inhabitants has been improved through the determination of the Montserratians themselves, the efforts of H.M Governor and the Montserratian Government, and a considerable allocation of funds by the UK.

Figure 2. Soufrière Hills volcano, Montserrat, February 2008 (Image courtesy of Prof. Peter Baxter, HPA)

Ash

The clouds of ash that form the pyroclastic flows are very hot, about 400ºC, and are capable of instantly igniting vegetation and buildings which they invade through windows and other openings. The hot ash convects upwards in billowing clouds and a plume of ash and gases will rise rapidly for thousands of metres in the atmosphere. A typical ash fall can deposit an inch or two of ash on the ground which can turn to mud when it rains and then dries out rapidly in the tropical sun. The ash feels like face powder with added grit and contains fine particles that fall into the < 10 µm aerodynamic diameter (PM10) category. During one ash fall, a particle monitor recorded > 10 mg/m^3 PM10 under a protective roof adjacent to a swimming pool. Similarly high concentrations are found when ash clouds are thrown up by vehicles and during grass cutting, road cleaning and, of course, ash clearing operations. Workers and others are exposed to this particulate matter, of which a significant fraction is of a size that can be inhaled and deposited deep inside the lung. Is this a hazard? Undoubtedly, yes. How large is the risk associated with such exposure? That is much more difficult to say.

Research on the ash

A detailed review of work on the toxicological properties of ash produced by the Montserrat volcano, and by other volcanoes, has been provided by Horwell and Baxter (2006).

Figure 3: Government Headquarters submerged in ash and debris following the eruption of the Soufrière Hills volcano, Montserrat (Image courtesy of Dr. Sarah Petrie, DfID)

Characterisation of the ash

Two key processes generate ash clouds on Montserrat: collapses of the dome of the volcano producing pyroclastic flows, and vertical ash columns generated during the special phase of explosive activity in 1998. The main exposure to humans occurs when ash is re-suspended from the ground deposits. Between 13 and 20 wt% of the particles generated by dome collapses fall into the PM10 size category. The < 10 µm diameter particles contain significant amounts (10 – 27 wt%) of crystalline silica, mainly in the form of cristobalite which has been generated in the heat and steam of the growing dome (for a detailed discussion see: Baxter, 1999; Horwell *et al*., 2001; 2003a; 2003b). Finding cristobalite in such high proportions in respirable particles has given rise to serious concerns about possible effects on the respiratory health of the population, especially children and outdoor workers as these are the most heavily exposed groups on the island. Perhaps the greatest fear has been that exposure could lead to silicosis; normally an occupational lung disease which, in some patients, can be progressive, ultimately disabling and fatal.

Epidemiological studies

A survey involving a respiratory questionnaire, lung function tests and chest X-rays in outdoor workers likely to be exposed to greater than average concentrations of ash, revealed no X-ray abnormalities and only a modest increase in respiratory symptoms and decreased lung function (Cowie *et al*., 2001a; 2001b). A study of school children (Forbes *et al*., 2003) with an emphasis on asthma, found an increased prevalence of wheezing in those moderately to heavily exposed to ash. A 4-fold increase in the prevalence of exercise-induced bronchospasm was also found. These effects might reasonably be attributed to the effects of acute exposure to an irritative aerosol; however, no evidence of effects of long-term exposure to ash has yet appeared.

Toxicological studies

Horwell and Baxter (2006) reported six studies. Of these, five comprised instillation studies and one was an inhalation study in rats. Given the cristobalite content of the ash, the results have been surprisingly unimpressive. This is not to say that the ash is inert but rather that it seems to be only moderately active, perhaps because the biological reactivity of the cristobalite has been modulated by the presence of other minerals and metals such as aluminium. In a study by Cullen *et al*. (2002) it was concluded that the ash was about as toxicologically active as mixed coal-mine dust. It was also suggested that activity could be related to Fe^{2+} content. This mechanism has been discussed at length in other contexts by Donaldson *et al*. (1997). Perhaps the most detailed study was that undertaken by Lee and Richards (2004); animals were dosed with anorthite (negative control), cristobalite (positive control) and dome-collapse ash. The anorthite had no effect, cristobalite produced marked inflammation with lung fibrosis, and the ash caused enlargement and fibrosis of bronchial lymph nodes by 49 weeks post-exposure, but no lung changes were observed. Further work is needed to understand why the ash is less toxicologically active than expected and whether this remains the case after the particulate matter has resided for some years in the lung.

Syntheses of the findings of the toxicological studies and comparisons with occupational exposure to silica and diatomaceous earth (perhaps the best comparator for the toxicity of Montserrat ash) have been entered into a model of ash dispersion and human exposure to estimate the future potential risks to the population of inhaling ash if the volcanic activity continues for another 10 years. The modelling showed that the risk of development of radiological signs of silicosis in most adults is about 1% after ten years and double this figure after 20 years of exposure (Hinks *et al*., 2006). For children and gardeners, the most exposed groups, the figures are slightly higher. These estimates are predicated on the assumption that the volcanic activity and exposure to ash on the island continues in the same pattern as in 1996-98. It should be noted that minor X-ray changes in people exposed to silica are not associated with clinical symptoms and do not invariably imply the onset of progressive disease leading to disablement and death.

Responses to the risk posed by exposure to ash

Some exposure to ash on Montserrat is inevitable. High exposure amongst groups of workers such as gardeners, road cleaners and amongst children playing outdoors is clearly a cause for concern. The former can be reduced by the use of appropriate personal protective equipment, including well fitting masks (unfortunately masks are not made in children's sizes). Preventing children playing outdoors is more difficult though the authors (Peter Baxter and Robert Maynard) have advised that this should be discouraged after ash falls. A programme of repeated surveys of worker and child health on the island is underway.

Conclusion

Conditions on Montserrat pose an unusual challenge to public health. However, the eruption also presents the most important scientific model yet for studying the health hazards of ash from explosive volcanoes around the world, including the Pacific Ring of Fire: about 10% of the world's growing population now lives in areas of active volcanism. The very severe dangers imposed by the volcanic eruption are easily recognised and have been dealt with by moving people away from the danger zones on the island. The risks to health posed by exposure to the fine particulate matter of the ash, whilst not negligible, are small in comparison and probably cannot be entirely removed as long as the island continues to be inhabited. Preventive measures to reduce exposure to ash in children, workers and the general population are important. That long-term involvement by the UK will be needed in the protection of public health on Montserrat seems certain.

Figure 4: Soufrière Hills volcano, Montserrat (Image courtesy of Dr. Sarah Petrie, DfID)

References

Baxter PJ, Bonadonna C, Dupree R, et al. (1999) Cristobalite in Volcanic Ash of the Soufriere Hills Volcano, Montserrat, British West Indies Science 283:1142 – 1145.

Cowie, H.A., Graham, M.K., Searl, A., Miller, B.G., Hutchinson, P.A., Swales, C., Dempsey, S. and Russell, M. (2001a) A Health Survey of Workers on the Island of Montserrat. (IOM TM/02/01). Edinburgh: Institute of Occupational Medicine.

Cowie, H.A., Searl, A., Ritchie, P.J., Graham, M.K., Hutchinson, P.A. and Pilkington, A. (2000b) A Health Survey of Montserratians Relocated to the UK. (IOM TM/01/07). Edinburgh: Institute of Occupational Medicine.

Cullen, R.T., Jones, A.D., Miller, B.G., Donaldson, K., Davis, J.M.G., Wilson, M. and Tran, C.L. (2002) Toxicity of Volcanic Ash from Montserrat. (IOM TM/02/01). Edinburgh: Institute of Occupational Medicine; p55.

Donaldson, K., Brown, D.M., Mitchell, C., Dineva, M., Beswick, P.H., Gilmour, P. and MacNee, W. (1997) Free radical activity of PM_{10}: iron-mediated generation of hydroxyl radicals. Environ. Health Perspect. 105(Suppl 5): 1285-1289.

Forbes, L., Jarvis, D., Potts, J. and Baxter, P.J. (2003) Volcanic ash and respiratory symptoms in children on the island of Montserrat, British West Indies. Occup. Environ. Med. 60: 207-211.

Hincks TK, Aspinall WP, Baxter PJ, Searl A, Sparks RSJ, Woo G. (2006) Long term exposure to respirable volcanic ash on Montserrat: a time series simulation. Bull. Volcanol. 68: 266-284.

Horwell, C.J. and Baxter, P.J. (2006) The respiratory health hazards of volcanic ash: a review for volcanic mitigation. Bull. Volcano 69: 1-24.

Horwell, C.J., Braña, L.P., Sparks, R.S.J., Murphy, M.D. and Hards, V.L. (2001) A geochemical investigation of fragmentation and physical fractionation in pyroclastic flows from the Soufrière Hills volcano, Montserrat. J. Volcanol. Geotherm. Res. 109: 247-262.

Horwell, C.J., Fenoglio, I., Ragnarsdottir, K.V., Sparks, R.S.J. and Fubini, B. (2003a) Surface reactivity of volcanic ash from the eruption of the Soufrière Hills volcano, Montserrat, with implications for health hazard. Environ. Res. 93: 202-215.

Horwell, C.J., Sparks, R.S.J., Brewer, T.S., Llewellin, E.W. and Williamson, B.J. (2003b) The characterisation of respirable volcanic ash from the Soufrière Hills Volcano, Montserrat, with implications for health hazard. Bull. Volcano 65: 346-362.

Lee, S.H. and Richards, R.J. (2004) Montserrat volcanic ash induces lymph node granuloma and delayed lung inflammation. Toxicology 195: 155-165.

Treves, F. (1908) The Cradle of the Deep: An Account of a Voyage to the West Indies. London: Smith, Elder.

Small Ground Movements Detected from Space Radars: A new Tool for Risk Assessment and Disaster Reduction

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Introduction

Radar satellites, in orbits 800km above the Earth, have been collecting data through the European Space Agency (ESA) since 1992, and have been providing information on ground movements at the centimetre scale. Just eight years ago, a new processing technique (PSINSAR) developed by TRE (Tele-Rilevamento Europa) in Italy, allowed a ten-fold improvement in capability so that movements of less than 1 millimetre per year can now be measured. Each radar reflection that persists (Permanent Scatterer, or PS) over the years of a study, can be used to determine the movement history of that point. Applications include landslides, subsidence, compressible soils, mines and engineered excavations, impacts of flooding, flood defences, ground water abstraction, and vulnerability to earthquake shaking. Mining subsidence and subsequent ground uplifts have been revealed, together with differential subsidence in flood plains, which leads to the prospect of microzonation for risk. Applications to mitigate landslide hazards have become relatively mature with the identification of areas at risk, and for warnings. For earthquake–threatened cities, this leading-edge technology heralds the prospect of vulnerability mapping over large areas, at low cost, with improved risk assessment, and the focusing of resources for remedial action. In order to build more awareness of this potential, the European Space Agency has sponsored a project, entitled GMES Terrafirma, to capitalise on its radar satellite data archives. Many city and landslide sites in Europe have already been processed to reveal their ground movement histories for up to 16 years since the first radar satellite was launched, and this long archive of raw data continues to be available for exploitation across all Member States and beyond. Some key examples are reported here.

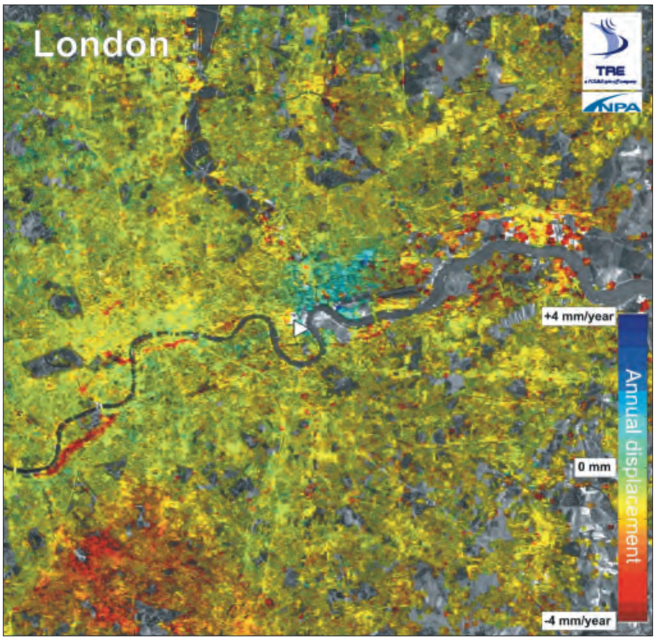

Figure 1: Interpolated Permanent Scatterer InSAR (PSI) image of a 900km² area of London showing average ground velocities in mm/yr away from the satellite, indicating subsidence (red), and towards the satellite, indicating ground heave (blue). The average number of PS points used is greater than 200/km² over the five-year study period, 1995-2000 (Courtesy, NPA & TRE. TRE are developers of PSInSAR and world-wide licensee of the POLIMI patent.)

London

Figure 1 shows that, over the 5-year study period in the 1990s, parts of the Streatham area (bottom left), were subsiding at around 3mm/yr, correlating with a lowering of the water table. Above this red patch, a SW-NE linear feature is subsidence over an electricity tunnel, and, above that, a red ribbon, W-E crossing the River Thames, follows the recent extension of the London underground. At 3mm/yr, this was a level of subsidence predicted by engineers and monitored on the ground by them over the five years. Further to the east (centre), the blue patch indicates ground heave of 2mm/yr, where the death of papermaking, printing and brewing industries 30-40 years ago, ended groundwater abstraction, with the natural water table recovering.

Further down the Thames, small patches of subsidence are observed along the river banks in the old docks area, which is being extensively redeveloped. The concern here is whether local subsidence increases flood risk, and further studies have been prompted by these PSI results.

Mining Legacies

The “Potteries” prospered from industries based on the abundant local resources of clay, ironstone and coal, leaving a legacy of mine workings but with some southern coal mines active until 1998. Figure 2 shows the results for the period 1992-2004 with up to 5mm/yr of uplift in the north, and up to 5mm/yr of subsidence in the south. The oldest abandoned mines are in the north with those in the south being closed more recently; the explanation for these movements is that groundwater rebound over decades causes the uplift, and subsidence continues for some years after the workings close, until the movement is reversed by the groundwater recharge. A similar study in Liege, Belgium has shown the same response but at about twice this annual rate of movement in both directions.

Landslides

The PSI technique has proved to be of practical importance in Italy and Switzerland through mapping areas at risk and identifying, within those areas, where there is current activity. In Italy, on average, 59 people die as a result of mass movements every year and the annual cost of landsliding is estimated at between €1bn and 2bn – or about 0.15% of its national gross domestic product over the last century. As we continue to become more urbanised and construction spills onto marginal land, we are likely to become more vulnerable.

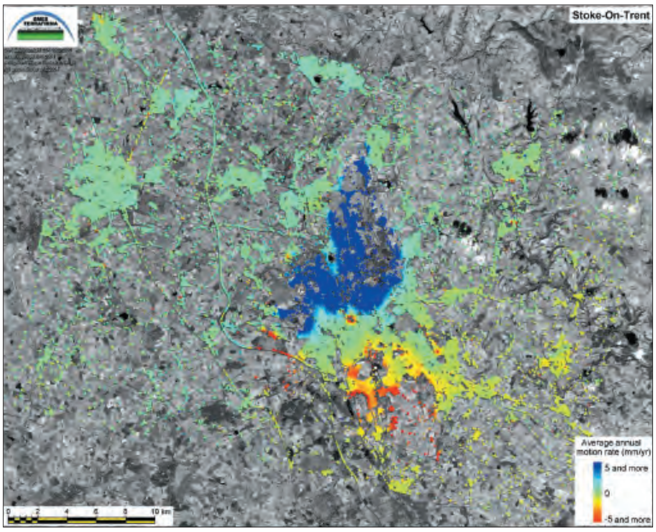

Figure 2: Stoke-on-Trent map of PS points colour-coded to show subsidence (red) and uplift (blue) in relation to a reference point.

The integration of the PSI data with ground-based geological and geotechnical information is, of course, important for all of the hazards described here, and there is often considerable knowledge available in landslide prone areas. With this new technique, we have found that the measurement of superficial displacements through PSI is often the most effective way of defining the behaviour of slope movements and, therefore, in predicting how they will evolve. For example, over Cutigliano village, in the Tuscan Apennines, it was possible to identify more than 200 PS measurement points along the slope (figure 3), and attribute the recent ground motion history to each one.

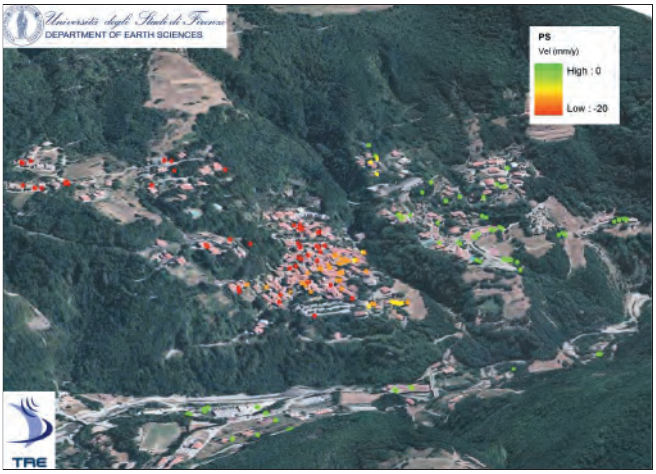

Figure 3: Landsliding and PSI results over Cutigliano village (Italy). Green = stability, grading through yellow to red = high deformation (courtesy University of Florence & TRE).

Vulnerable Ground

Because it is built over, it can be difficult to assess the strength of the near-surface geology which provides the foundations of towns and cities. There is benefit in knowing something about the vulnerability of the foundation materials for planning, construction and the impacts of natural hazards. We have found that the PSI technique can help, and the previous examples provide some specific insights. For a more general view, the PSI processing for Istanbul has added another dimension.

Figure 4 shows the PSI result with much subsidence in the newly-developed western part of the city, where the soft geology there also contributed to the greatest damage impact of the 1999 Izmit earthquake, centred some 90km to the east of Istanbul. The eastern part of the city is built mostly on solid rock and is seen to be largely stable in the PSI image (green).

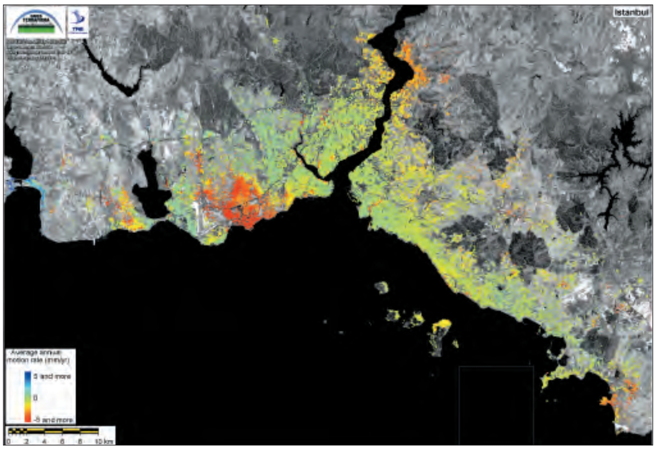

Figure 4: Effective Subsidence map of Istanbul derived from PSI data. Green = stability, grading through yellow to red = high subsidence areas (Courtesy: TRE & Terrafirma).

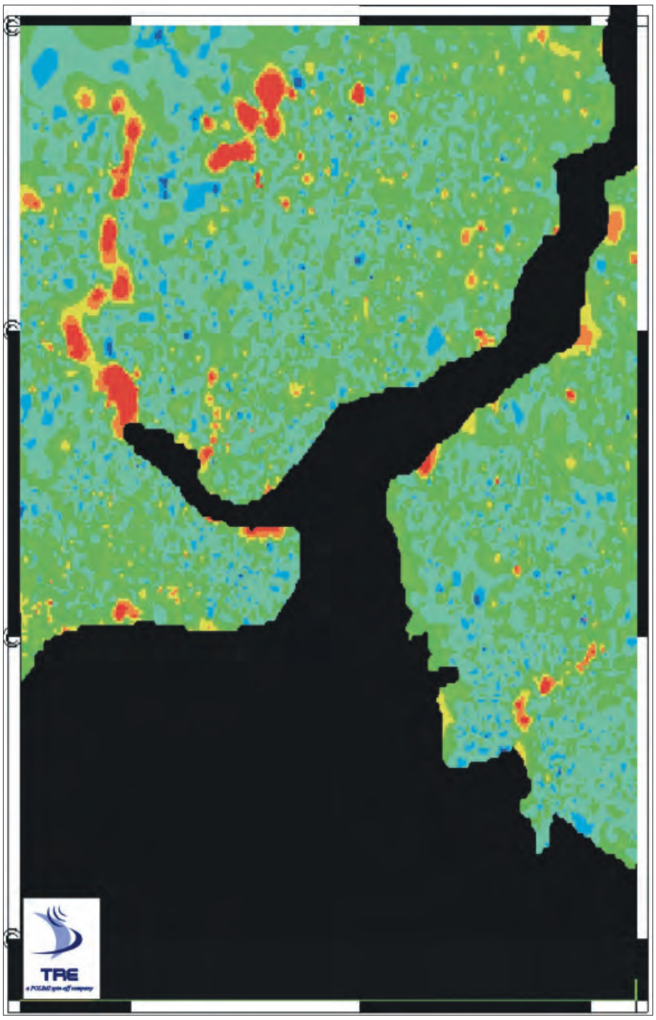

Figure 5: Detail of PSI subsidence data (red) revealing vulnerable soft foundation geology in the ancient river channels and coastal embayments of Istanbul (Courtesy: TRE & Terrafirma).

Zooming in on the centre of Istanbul (Figure 5), we reveal considerable detail of current subsidence depicting the filled-in creeks (Golden Horn, on the left), river valleys, and former fishing harbours along the coast of the Bosphorus (on the right). These are the areas, now built over, which are vulnerable to the next big earthquake. There is over a 50% chance of one with magnitude 7 occurring only 50km to the south within the next 30 years. Of course, understanding a city's vulnerable foundations is important even for those which are not prone to such imminent risks.

Flooding

Following the disastrous impact of hurricane Katrina in August 2005, TRE, in collaboration with the University of Miami, applied the PSI technique to create the first space-derived image of subsidence across the city (Figure 6). It focused on the 3 years before Katrina struck, confirming how the delta is settling relative to mean sea level and, crucially, how subsidence varies across the city between extremes of 2mm/yr and 20mm/yr; most of it 5 -10mm/yr. Of course, over many years, these numbers become significant, and the mapping shows how risks become much greater in some parts relative to others.

This study also yielded radar reflecting points on the protecting levees revealing high levels of subsidence there also.

Figure 6: PSI subsidence image of New Orleans for the 3 years before hurricane Katrina struck in 2005. Yellow areas are subsiding at 5mm/yr and red ones at 10mm/yr or greater (Courtesy: TRE and Miami University).

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Guidance on Windstorms for the Public Health Workforce

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This report provides guidance on windstorms for public health professionals who may need to deal with their effects in their work.

It characterises windstorms in the UK and presents data on their impact in the UK. The second section briefly reviews the literature before a discussing the public health implications of windstorms in section three.

Introduction

Due to its proximity to the North Atlantic, the UK is one of the windiest countries in Europe and sustains damage to property and human life almost every year. While no part of the UK is safe from the risk of windstorms, the South-West, Northern Ireland, Scotland and Northern England experience greater levels of windstorm activity.

Table 1 outlines how severe wind events in the UK may be classified. Like other meteorological phenomena, windstorms become natural disasters when human life is affected or interrupted[1].

It has been observed that windstorm activity (measured using a proxy of windstorm damage) tends to occur most often during the winter months, with over half the total damage occurring in the months of January and February[3].

Windstorms are usually characterised by their gusts, and are most commonly measured in metres per second, although knots per hour is also used. Two knots per hour equal one metre per second. Wind gust speed taxonomy is presented in Table 2.

Like many other severe weather conditions, windstorms are forecast in the UK by the Met Office. The current definition of 'severe gales' (which warrants the issue of a weather warning) is 'repeated gusts of 70 m.p.h. or more over inland areas'[6]. It is worth noting that the highest gust measured during the Great Storm of 1987 was 54.6m/s.

During 'severe gales', the weather warning is issued to police control and then onto local and national media. The Local Resilience Fora are also important in assessing the risk of storms and providing guidance on appropriate strategies.

Meteorological forecasts are useful public health tools, and an effective working relationship between forecasters and public health departments can enable timely public health interventions[7]. The World Meteorological Organization's THORPEX (THe Observing system Research and Predictability EXperiment) project is currently developing more timely and accurate weather forecasts and decision-making tools that minimise the impact of natural hazards.[8]

Table 1: Wind event classification

Classification	Description	Frequency and Examples
1. Temperate Windstorms	Large scale, low pressure systems with strong winds occurring across a track that may be 1000km	Relatively frequent: e.g., 'The Great Storm', October 1987; 'The Burns Night Storm', January 1990.
2. Downbursts	Strong winds produced when a column of sinking air hits ground level and spreads out in all directions. Associated with thunderstorms.	e.g., London, June 1994.
3. Tornadoes	Extremely severe winds occurring on a local scale affecting an area of 1-10km2.	Approximately 32 a year[2]: e.g., Birmingham, July 2005.

Table 2: Wind gust speed taxonomy

Wind gust speed		Possible effects[4]
20m/s	= 39 knots	Elderly people could be blown over. Cyclists could be blown down. High-sided vehicles become unstable.
30m/s	= 58 knots	More serious incidents occur. "Threshold" level; everyone should be warned to stay indoors[5].
45m/s	= 87 knots	Trees fall down. Building and structure damage.

Table 3: Comparison of Impacts of Floods and Windstorms in the UK (1990-2008)

Disaster Type	Number of Disasters	Total deaths	Mean deaths per disaster	Total persons affected	Mean persons affected* per disaster	$ damage costs (,000s)
Floods	21	32	1.52	345,868	16,470	15,666,230
Windstorms	22	244	11.09	488,304	22,196	11,906,450

* persons affected includes those people suffering injury or trauma, those people in need of immediate shelter, and those people requiring immediate assistance, including evacuation
Source: International Emergency Disasters Database (EM-DAT)[11]

Review of Health Impacts

A comprehensive review of the health impacts of windstorms in the UK was conducted in 2000 by Baxter *et al*. and their findings were included as a chapter in the Department of Health publication 'Health Effects of Climate Change'[9]. This review summarises the impact of windstorms in the UK in recent times and also suggests the likely impacts in the future. The most common effects on humans from windstorms are road traffic accidents (overturning vehicles, collisions with fallen trees) and individual accidents (being blown over, or struck by flying debris/masonry). Building failure represents a less significant, but still important, impact on human life (falling chimneys etc).

A study of the wind-induced accidents of road vehicles confirmed the vulnerability of vehicles when being driven in wind gusts exceeding 20 m/s. Reasons for accidents include overturning (generally only high-sided lorries and vans), course-deviation and collision with falling or fallen trees[10].

Flooding is another significant natural disaster in many parts of the UK; however it is worth noting that over the last 18 years windstorms had greater impact in the UK than flooding across most categories recorded by the Centre for Research and Epidemiology of Disasters, as detailed in Table 3. These data are based on compilation of information from a variety of sources, however the definition of mortality and morbidity that directed this compilation is unknown, therefore they should be interpreted with caution.

A thirty-year survey of gale damage in the UK outlines the number and nature of deaths and injuries caused directly or indirectly by windstorms. Between 1962 and 1993 there were approximately 6 deaths and 144 injuries each year [12]. More recent data collected by EM-DAT indicates that the annual death rate from windstorms in the UK is approximately 13.

Being outside during the windstorm's peak activity emerges as the primary risk factor for death and injury. It has therefore been recognised that windstorms peaking in the early hours of the morning have a smaller impact than those peaking during working hours. In recognising this, it is possible to describe a 'worst reasonably foreseeable scenario' that may occur in the UK. This would be characterised by a windstorm hitting densely populated areas such as London and the South East at a time when large numbers of people would be leaving work, travelling or congregating outside. Predictions of >100 fatalities, 90 seriously injured and >400 minor injuries have been suggested, with even more devastating impacts if a large building with a weak roof failed[13].

Table 4: Notable windstorms in the UK since the 1987 'Great Storm'

The 'Great Storm' – 15-16 October 1987

Location: South-East England
Peak Storm Activity: 2-6am
Maximum gusts: 45-50 m/s (maximum recorded 54.6m/s)
Number of people affected: 25 million
Number of deaths: 21

Relatively few injuries were recorded as most people were in bed at the time the storm struck. The gusts during this incident were exceptional in the South East of England (having a return period of 200 years)[18]

The 'Burns Night Storm' – 25 January 1990

Location: Southern England and Wales
Peak Storm Activity: 9am-3pm
Maximum gusts: 45 m/s
Number of deaths: 47
Number of injured: 69

The marked difference in the number of fatalities can be mostly attributed to the time of the day when the storm struck.

London Thunderstorm – June 1994[19]

A combination of peak grass pollen concentrations in London and an unusually large mesoscale convective system produced a sudden and extensive epidemic of asthma.

Birmingham Tornado – July 2005[20]

Location: Kings Heath, Moseley, Sparkbrook and Balsall Heath
Peak Activity: NK
Maximum wind speeds: 42-58 m/s
Number of injured: 20 (three seriously)
Damaged properties: 420

This sudden, short-lived event was stronger than most tornadoes experienced in the UK. Damage was high due to the built-up urban location.

Windstorm reports from around the world commonly describe an increased incidence of carbon monoxide poisoning, caused by use of portable generators in confined or poorly ventilated areas[14]. This tends to occur when power outages are combined with colder temperatures.

Increased incidence of asthma attacks has been documented in connection with summer thunderstorms in UK and Australian cities. However, this relationship seems to depend on other aerobiological characteristics such as allergen concentrations[15].

Psychological impacts in the community may also persist well into the post-windstorm phase. A study of psychiatric morbidity after Hurricane Andrew in 1992 concludes that several outcomes are possible, including depression and post-traumatic stress disorder, with the common risk factor being severe damage[16].

The Department of Health recently updated the 'Health Effects of Climate Change in the UK' documentxvii. Nothing was added to the windstorm section.

Case studies in the literature tend to describe specific incident-response evaluations in the USA where windstorms (along with tropical cyclones) pose a much greater threat to human life. However, some reliable media reports can provide information relating to the impact of high-wind events in the UK. These are presented in Table 4.

Public Health Implications

The impacts of windstorms are multifarious. A summary is presented within Figure 1, which also includes the five phases of a disaster as outlined by Noji[21].

It is important to recognise that the burden of a windstorm does not fall only in the period of high wind activity. An appropriate set of actions is therefore necessary to provide timely support to affected communities *before, during and after* a windstorm event. It is not unimaginable for the larger proportion of a windstorm's burden to occur once normal wind activity has resumed (from carbon monoxide poisoning, accidents during clean-up, psychosocial stress).

Although thresholds are in place to classify windstorms, the local setting can also serve to exacerbate windstorm impact. A gust of 30 m/s may cause no damage or significant damage, for example if occurring in an area with newer or older housing respectively. Similarly, areas surrounding tower blocks are more prone to high gust speeds as wind can be deflected and accelerated towards the ground, elevating the risk for people in the area. Improved building design now takes this into account and wind-loading limits are enforced[22].

From American hurricane case-studies there is also robust epidemiological evidence showing a negative association between socio-economic status and psychological distress[23]. This is characteristic of the broader issue that certain populations may be affected disproportionately. These high-risk groups (including low-income, non-English speaking, institutionalised, the elderly) are therefore in need of support beyond that provided for 'general risk' groups.

Experience from Hurricane Katrina in 2005 provides many lessons that are relevant for the UK. The New Orleans public health officials highlighted, for example, the need to determine an appropriate communication strategy[24]. This is relevant wherever a disaster occurs and requires information from a variety of sources, of which the public health department is just one. This information should then be translated into a message that reassures the public. Poorly thought-out communications can impede recovery.

Figure 1

Time-line:	PRE–STORM		STORM	POST–STORM	
Framework of Disaster Phases (Noji, 1997)	**1. Interdisaster**	**2. Predisaster**	**3. Impact (peak windstorm activity)**	**4. Emergency**	**5. Reconstruction**
Public Health Action	**Preparedness and mitigation measures Identify "at risk" populations Training**	**Protective activities Possible evacuation Communicate safety messages**	**Inter-agency communication (NB Are PH workers at risk themselves?)**	**Communicate safety messages Surveillance Advice**	**Lessons learned**
Health Risks		**Accidents and falls whilst securing/fixing roofs and windows**	**Building collapse Flying debris Blown over into a stationary object, a moving vehicle or a body of water Road traffic accidents NB Minor injuries may not present whilst high-winds persist**	**Electrocution Accidents during clean-up (chainsaws, bonfires etc) Carbon monoxide poisoning (If evacuation has occurred: health problems associated with crowding and poor sanitation)**	**Accidents and falls whilst repairing building damage**
	Psychological impacts including anxiety, stress, bereavement and post-traumatic stress disorder				

With their propensity to mostly occur in the winter months it should be noted that windstorms have the potential to arrive when the health service may be already stretched with seasonal epidemics such as influenza[25].

Conclusions and Recommendations

Windstorms and their impacts in the United Kingdom have not received much attention in the literature. It is hoped that more research into specific windstorm events and their impacts is carried out to fully capture the multifarious impacts of these dangerous events.

It is recommended that guidance for public health professionals be developed to assist in the management of health impacts of windstorms. This guidance should cover the following areas, most of which have been described in this report:

- The definition, characterisation and trends of windstorms in the UK
- The diverse types of health outcome anticipated in a windstorm
- The relevant bodies working on windstorms (eg THORPEX)

It is also recommended that local Health Protection Units should consider identifying those areas that are particularly vulnerable to the effects of windstorms such as neighbourhoods with poor-quality buildings and caravan parks. Similarly, research on how windstorms may change as a result of climate change should be directed to public health departments so they are aware of any increased risk in certain areas.

References

1 Noji EK (1997) 'The Public Health Consequences of Disasters' Oxford University Press, New York

2 http://www.torro.org.uk/TORRO/about/mediafacts.php

3 Buller PSJ (1993) 'A thirty-year survey of gale damage to buildings in the United Kingdom' in Cook NJ 'Wind Engineering: 1st IAWE European and African Regional Conference' Thomas Telford, London

4 Department of Health (2001) 'Health Effects of Climate Change in the UK 2008'

5 Cugnoni HL & Whitworth I, (1992), 'Injuries related to wind speed' Annals of the Royal College of Surgeons of England, Vol. 74(4)

6 http://www.metoffice.gov.uk/weather/uk/guide/key_warnings.html

7 Hughes S, Bellis MA, Bird W & Ashton JR (2004) 'Weather Forecasting as a Public Health Tool' Centre for Public Health, Liverpool John Moores University

8 http://www.wmo.int/pages/prog/arep/thorpex/

9 Department of Health (2001) 'Health Effects of Climate Change in the UK'

10 Baker CJ & Reynolds S (1992) 'Wind-induced accidents of road vehicles' Accident Analysis and Prevention, Vol. 24(6)

11 The OFDA/CRED International Disaster Database www.emdat.be – Université Catholique de Louvain – Brussels – Belgium. Data version v12.07. Data accessed 18th April 2008.

12 Buller PSJ (1993) 'Deaths and Injuries caused by the wind, 1962-1993' Building Research Establishment, Watford

13 Department of Health (2001) 'Health Effects of Climate Change in the UK 2008'

14 Bourke LB, Siegel JM, Kano M, Wood MM (2006) 'Weathering the storm: the impact of hurricanes on physical and mental health' Annals of the American Academy of Political and Social Science Vol. 604(129-51)

15 Venables KM, Allitt U, Collier CG, Emberlin J, Greig JB, Hardaker PJ, Highham JH, Laing-Morton T, Maynard RL, Murray V, Strachan D * Tee RD (1997) 'Thunderstorm-related asthma – the epidemic of 24/25 June 1994' Clinical and Experimental Allergy, Vol. 27(725-736)

16 Bourke LB, Siegel JM, Kano M, Wood MM (2006) 'Weathering the storm: the impact of hurricanes on physical and mental health' Annals of the American Academy of Political and Social Science, Vol. 604(129-51)

17 Department of Health (2008) 'Health Effects of Climate Change in the UK 2008: An update of the Department of Health report 2001/2002'

18 Buller PSJ (1988) 'The October Gale of 1987: Damage to buildings and structures in the south-east of England' Building Research Establishment

19 Venables KM, Allitt U, Collier CG, Emberlin J, Greig JB, Hardaker PJ, Highham JH, Laing-Morton T, Maynard RL, Murray V, Strachan D * Tee RD (1997) 'Thunderstorm-related asthma – the epidemic of 24/25 June 1994' Clinical and Experimental Allergy Vol. 27(725-736)

20 http://news.bbc.co.uk/1/hi/england/west_midlands/4725279.stm

21 Noji EK (1997) 'The Public Health Consequences of Disasters' Oxford University Press, New York

22 Penwarden AD & Wise AFE (1975) 'Wind environment around buildings' Building Research Establishment

23 Bourke LB, Siegel JM, Kano M, Wood MM (2006) 'Weathering the storm: the impact of hurricanes on physical and mental health' Annals of the American Academy of Political and Social Science Vol. 604(129-51)

24 Goldman L & Coussens C (2007) "Environmental Public Health Impacts of Disasters: Hurricane Katrina, Workshop Summary" The National Academies Press, Washington DC. Accessed online 23/04/2008: http://books.nap.edu/openbook.php?record_id=11840&page=3

Reducing adverse health outcomes from natural disasters and chemical incidents by working for school safety

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Introduction

The health of any community is, in part, dependent on the schools in that community. Schools play an ever increasingly important role in the life of communities throughout the world, especially in the South Asian region.[1] The link between health and schools is acknowledged by UK central governments[2], which recognise that the health of populations can be affected by schools. Schools are centres of learning and locations for community activities, and they are often seen as safe havens. Their health impact is both long term, through the education offered by the school, and short term, through the opportunity that schools provide as key elements in the preparedness and response to any disaster. The health benefits of working with schools are well recognised, but in national natural disaster and chemical risk management plans, schools and their design have not been given adequate attention, and poor disaster management has too often left them isolated, inaccessible in times of disaster, and away from relief and rescue efforts.

Health outcomes in schools after natural disasters and chemical incidents are affected by the vulnerability of the schools and the people that use them. The term 'vulnerable' has many different meanings[3] but broadly it can be defined as, 'a dynamic, intrinsic feature of any community that comprises a multitude of components and indicates damage potential' (adapted from Thywissen [3]).

For the health of populations associated with schools there are at least four components of vulnerability that should be considered, these include:

- **Vulnerability of place** e.g. a school built on contaminated land or a school built within flood zones or on a fault line when located in areas of high seismic activity
- **Vulnerability of receptor** (children, by nature, are always a vulnerable section of the population)
- **Vulnerability of susceptible receptors grouped together**: This is a major feature of infectious disease spread and non-infectious environmental hazard risks.
- **Community psychological vulnerability** because of what schools represent and who they house.

Recognition of areas of vulnerability in any society is important for two reasons. Firstly, without such recognition implementation of chemical and natural disaster response plans has the potential to increase the inequalities that exist between the least and most advantaged areas or groups in society. Secondly, work with any vulnerable area or group can reduce overall risk in a society by a much greater degree than work with more resilient sections of it. Taking school safety as an example, disaster risk reduction involving, say, educating pupils about risk reduction and appropriate responses to disasters not only educates the children, but is an effective and sustainable way of changing the attitudes of a whole community.[4]

Convincing evidence that the number and seriousness of natural disasters is increasing is available.[5] This article takes a global perspective and reviews a series of chemical and natural disasters that affected schools and resulted in significant health effects. It also considers current international developments and recommendations that aim to improve health by integrating greater understanding and resilience to natural and chemical disasters into educational structures and processes.

Natural disaster and chemical incidents that affected schools

Schools are both potentially vulnerable to disasters and important in coping with disasters. They therefore deserve special attention. The most memorable school disaster in the UK is summarised in Box 1.

Box 1: UK school disaster: Aberfan

On 21 October 1966, 116 children and 28 adults were killed in the Welsh mining village of Aberfan and its companion village Merthyr Vale when an avalanche of coal slurry engulfed the village primary school and several houses.[6] 145 children survived. Subsequently, a large proportion of the survivors suffered from sleeping difficulties, nervousness, lack of friends, unwillingness to go to school and enuresis. Media coverage and political concern were marked in the UK following this disaster. Although relatively few scientific papers were written as a result of this disaster, two are quoted below.

In 1975 Williams and Murray Parkes conjectured that the increased birth rate in Aberfan and Merthyr Vale observed during the first five years after the disaster was mainly a consequence of a process of biosocial regeneration by couples who had not themselves lost a child. [6] They concluded that this process could not bring back the children who died or remove all the scars of bereavement.

Reports suggest that trauma in childhood can lead to post traumatic stress disorder (PTSD), and PTSD symptoms can persist for as long as 33 years into adult life. However, in their study examining the long-term effects of surviving the1966 Aberfan disaster in childhood, Lewis *et al*. reported that rates of other psychopathological disorders are not necessarily raised after life-threatening childhood trauma.[7]

Table 1: Some of the significant disasters affecting schools 2003-2007

2003	Bingol, Turkey	84 children and teachers died in collapsed school building in a moderate earthquake; 4 schools collapsed; 90% of schools were impacted and education disrupted.
2003	Xinjiang, China	900 classrooms in dozens of schools collapsed in earthquake, 27 minutes before thousands of children returned to their classrooms; Middle school collapsed killing at least 20 students.
2003	Dominican Republic	Earthquake caused 18,000 students to lose their classrooms at 12.45; no one in the schools at the time
2004	Tamilnadu, India	93 children died in a fire due to explosion of a cooking gas cylinder
2004	Bangladesh	1,259 school buildings were lost to floods and 24,236 were damaged.
2004	Indian Ocean basin	Tsunami: destroyed 750 schools in Indonesia and damaged 2,135 more; 150,000 students without schools; 51 schools destroyed in Sri Lanka, 44 in Maldives, and 30 in Thailand.
2005	Bam, Iran	Earthquake: 67 of 131 schools collapsed; remaining schools heavily damaged.
2005	Gulf States, USA	Hurricane Katrina: 56 schools destroyed and 1,162 damaged; 700 schools closed and 372,000 children displaced; 73,000 college students displaced; $2.8billion was spent to educate displaced students for a year.
2006	Uganda	13 children died in a school dormitory fire where children were using candles for lighting.
2006	Philippines	Super Typhoon Durian caused $20m USD damage to schools including 90-100% of school buildings in three cities and 50-60% of school buildings in two other cities.
2007	Bangladesh	Cyclone destroyed 496 school buildings and damaged 2,110 more

A list of references for these incidents is available from the authors

Table 1 lists some recent significant global events between 2003 and 2007 which affected schools.

Experiences in the recent past have highlighted the need to bring attention to the threat from natural disasters such as fires, floods, earthquakes and surrounding industrial activities that expose students to danger in schools. Short summaries of incidents and concerns are given below for fires, floods and earthquakes.

Fire

The most common hazard in schools is fire, but these usually do not cause as significant an impact as floods or earthquakes. In the UK, DC McIntosh in his April 2007 report on the campaign for sprinklers in schools reported that property losses from UK school fires, many of which are started deliberately, run to over £70 million each year.[8] He also reported that the loss of a school adversely affects learning, upsets children and harms communities by removing an asset that is often widely used outside school hours (Box 2). He added that fortunately no child has been seriously hurt in a school fire but there have been several incidents where death or injury was only narrowly avoided.

Fire prevention measures in schools include

- elimination and prevention of fire hazards;
- maintenance of electrical equipment;
- standard fire prevention through awareness;
- smoke detectors and sprinkler systems.

Important measures to mitigating fire risk are:

- doors of classrooms and buildings open outwards for safe evacuation;
- exit doors are clearly marked (above and below);
- exit route maps are posted on each corridor and in each classroom;
- fire suppression equipment is available on each corridor;
- fire suppression equipment is maintained regularly (e.g. annual testing);
- staff and older students receive fire suppression training (use of fire extinguishers, blanket, bucket, sand, hose);
- schools conduct regular fire drills.

Box 2: Example of the consequences of a school fire

A primary school in Cambridgeshire was badly damaged in an overnight fire caused by arson in September 2004. No child or adult was hurt during the fire but the effects on the school continued for many months causing concern and disruption for many months (figure 2).

The School provided a good standard of education, despite suffering very significant disruption, finally moving back into its new building in 2006. The experience caused long lasting effects on the school and the community. The staff and pupils moved to other accommodation temporarily and then back to their old site in mobile classrooms. Strong leadership by the head teacher and very caring staff and governors combined to support the children well through this difficult period of rebuilding. As a result, pupils continued to progress well in their work and came through the experience successfully. The pupils reported that they were excited by the opportunities of the new building. Parents recognised the efforts the school had made and the success it had achieved.

The Ofsted report on the school in January 2007 stated that the leadership of the school has overcome the very significant disturbance caused by the fire, the subsequent relocation and rebuilding of the school, and the loss of nearly all resources and records. From 2004 -6, vital assessment information has been collected again, enabling teachers to make accurate evaluations of the school's strengths and needs.

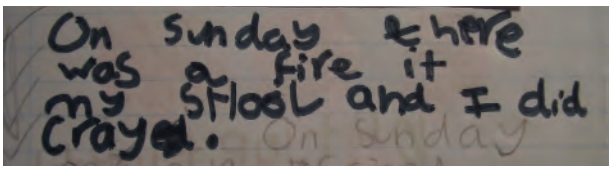

Figure 2: Six year old's diary for the week after the fire at her school (on Sunday there was a fire at my school and I did cry) © Elizabeth Head

Floods

The tsunami of December 2004 caused significant harm to the housing stock in many countries across the Indian Ocean basin, including Aceh and Nias in Indonesia, parts of Thailand, Sri Lanka, Maldives, Bangladesh, Myanmar, Somalia's eastern coast in East Africa[11]and India[12], affecting many students.

However, western countries have also been affected; the flooding across England and Wales in summer 2007 indicated that even well-developed countries are vulnerable. Extensive reporting of the many issues from these summer floods resulted in the Pitt Review. In addition, one press release[13] dated Wednesday, 5 September 2007, particularly pertinent to schools, pupils and staff reported that as many as 8,000 pupils in schools hit by the severe weather were having a few days extra holiday as final repairs are made to their schools. The report also stated that a total of 857 schools were affected by the weather in June and July, with some 8,055 pupils affected and 21 schools not yet fully open. These were described as 17 primary schools, two secondary schools and one special needs school.

The Pitt Review, published in July 2008, stated that the total cost of the summer 2007 floods runs into billions of pounds, with damage caused by the floods affecting individuals, homeowners, farmers and businesses, as well as public buildings and infrastructure, such as schools and roads.[14] Months after the floods, hundreds of school children in some of the worst affected regions were still being taught in temporary classrooms. More than 90 schools were damaged. An interim conclusion of the review is that awareness should be raised in flood risk areas and a range of mechanisms identified to warn the public, particularly the vulnerable, in response to flooding.

Earthquakes

In 2008, Walker reported that almost every week, seismic events are felt somewhere in the UK; most, but not all, are earthquakes of which over 100 are detected each year, with about 20% of them felt by people.[15]

Two recent international examples of earthquake demonstrate the vulnerability of schools and their pupils in such disasters. They are:

- The earthquake in South Asia on October 8, 2005, showed the significant vulnerability of the region's schools. In Pakistan over 8,000 out of 9,000 schools were either destroyed or damaged beyond repair by the earthquake. Over 17,000 school-age children perished in the collapsed schools, representing approximately 23% of the total deaths, and over 20,000 more suffered serious injury. In some districts 80% of schools were destroyed. [16]

- A 7.9 Richter scale earthquake on May 12, 2008, directly affected about 10 million people across Sichuan province of China with reports stating that more than 50,000 people may have died. In one report of the Juyuan Middle School near Dujiangyan, about 50km (32 miles) from the epicentre, parents tried to reach 900 children trapped in the rubble.[17] More details are emerging at the time of the preparation of this paper.

These earthquakes are yet another remainder of the need for policy, public and private sector engagement, and investments to make schools more resilient to earthquake and other hazards.[18]

Improving health outcomes after natural disasters and chemical incidents

In assessing how to improve health outcomes after chemical incidents and natural disasters, the following sources are highlighted for information:

- The World Disaster Reduction Campaign
- The International Strategy for Disaster Reduction
    - Early warning
    - Raising awareness within school communities
- Coalition for Global School Safety
    - Building a culture of prevention
    - Ensuring that schools are a structurally safe and health promoting environment

The World Disaster Reduction Campaign

The World Disaster Reduction Campaign 2006-2007 was launched in Paris in June 2006 by UN/ISDR secretariat and UNESCO, with support from the French Government. Its theme is: "Disaster Risk Reduction Begins at School". [18] This theme was chosen because:

- it is in line with the Priority 3 of the Hyogo Framework for Action 2005-2015: "Use knowledge, innovation and education to build a culture of safety and resilience at all levels"[19,20]
- schools are the best venues for forging durable collective values; therefore, they are suitable for building a culture of prevention and disaster resilience.

The World Campaign focuses on promoting the safety of school buildings and the mainstreaming of disaster risk reduction into school curricula or at least school activities. In other words, the World Campaign seeks to promote disaster resilience in schools and through schools.

This campaign promotes the inclusion of disaster risk reduction knowledge into primary and secondary school curricula in countries prone to natural hazards, including local risk assessment and disaster preparedness programmes with the participation of secondary schools acting as a resource centre for disaster risk reduction, and protection and strengthening of schools, through proper design, retrofitting and rebuilding, to make them resilient to natural hazards.[21]

The International Strategy for Disaster Reduction

Early warning

The International Strategy for Disaster Reduction (ISDR) recommends an improved understanding of early warning. [18] ISDR report that natural hazards, such as storms, droughts, volcanic eruptions, or earthquakes, need not mean disaster. A disaster occurs only if a community or population is exposed to the natural hazard and cannot cope with its effects. Thus, torrential rain in the middle of an ocean will not cause a disaster, but the same heavy rainfall on a vulnerable population may result in flooding, landslides and loss of life. A minor drought may cause a famine if a region's agricultural production is highly stressed by civil war. As considered earlier, vulnerability is the potent additive that mixes with natural hazards to cause disasters. Early effective warning systems are also needed. ISDR recommend that the Four Elements of Effective Early Warning Systems are

- **Risk knowledge** Systematically collect data and undertake risk assessments

- **Monitoring and warning service** Develop hazard monitoring and early warning services

- **Dissemination and communication** Communicate risk information and early warnings

- **Response capability** Build national and community response capabilities

ISDR consider that a complete and effective early warning system comprises these four elements, spanning knowledge of the risks faced, through to preparedness to act on early warning. Failure in any one part can mean failure of the whole system of risk knowledge, monitoring and warning, dissemination and communication, and response capacity.

Raising awareness within school communities

In the ISDR publication '*Towards a Culture of Prevention: Disaster Risk Reduction Begins at School*, 2007', the good practice of raising awareness within school communities is recommended, as well as building a culture of prevention and making school buildings safer. [18] A French Government joint initiative by the ministries of National Education, Health and the Interior provides an example of risk education as part of the national curriculum for around 12 million students from primary to tertiary levels. Teachers are given training and are able to inform children of risks, preventive measures, survival techniques, emergency drills and their responsibilities in a disaster. This risk education, which has been successfully integrated into the national curriculum to sensitise school children to risk reduction, was reported on in the Pitt review (Learning lessons from the 2007 floods). [14] From the information received by Pitt, early indications in France suggest that the initiative has been successful in getting schools to develop specific risk reduction plans and carry out exercises. Such developments are needed in other countries, including the UK.

Coalition for Global School Safety

The Global Schools Project: Coalition for Global School Safety (COGSS) is dedicated to fostering, supporting and encouraging disaster risk reduction in the education sector. COGSS supports global, regional, national and sub-national, local and grassroots efforts to bring together expert and local knowledge in order to:

- reduce the vulnerability of school infrastructures
- integrate risk knowledge concepts into formal education curriculum at all levels
- educate the public at large and promote public participation in disaster risk reduction
- serve as a clearing house to provide a focal web site
- share global school safety efforts through documents, mailing lists and links, and providing information free of charge.[22]

COGSS works with other related organisations, including the UN-ISDR. [18] The UN-ISDR aims to build disaster resilient communities by promoting increased awareness of the importance of disaster reduction as an integral component of sustainable development, with the goal of reducing human, social, economic and environmental losses due to natural hazards and related technological and environmental disasters. [18] An example of good practice which comes from the Government of St Kitts and Nevis is the construction of buildings less susceptible to hurricanes, not only to give pupils less vulnerability to effects of earthquakes but also to provide built infrastructure if the rest of the buildings in the area are damaged by a hurricane.[23]

Building a culture of prevention

COGSS recommends that national governments develop a school safety policy as part of their national development plan that is proactive and focuses on preparedness and mitigation. School safety policies should reflect local physical and socio-cultural realities, and priorities of state and local entities. Groups who are also linked to COGSS have contributed to the development of safety preparedness. These include Risk RED (Risk Reduction Education for Disasters), who published a school disaster reduction & readiness checklist in May, 2008. [24] This includes sections on assessment, planning and physical protection, including specific information for earthquake and windstorm, and flood, storm and tornado, response capacities, and supplies and skills.

Ensuring that schools are a structurally safe and health promoting environment

The COGSS model is to first prioritise, consider uniform building codes, and then address the broader policy context issues:

- **The very first priority** for school building safety is for every *new* school to be a safe school. This is inexpensive when implemented consciously and diligently during the design and construction of each new school.

- **Uniform building codes** provide a higher standard for the performance of school buildings than for normal buildings. An international rule of thumb is that school buildings are normally designed to be 1.5 x the strength of regular buildings. Engineered buildings can be designed for higher standards of performance – such as being able to be immediately occupied after a severe earthquake, flood or cyclone to be used for community shelter or emergency operations. Whether new schools are built by local communities, through projects or programs of government agencies, or together with support from external donors, there is a need for clear and comprehensible building guidelines to be provided, with support from relevant government authorities. This usually requires cooperation between ministries of education and a public works or construction standards authority.

- **The broader policy context** for disaster-resistant construction involves:
  - standard building codes relative to hazard conditions
  - a transparent process for planning, design, regulation and enforcement decisions
  - qualification requirements for professionals engaged in engineering and design and construction of school facilities
  - independent assessment of design, construction and maintenance of school facilities
  - technical support for all phases, and skill training for builders where needed.
  - active public stand against corruption, and liability for all contractors. This may include a "zero tolerance" policy, well-publicized campaign, and severe penalties for infraction.
  - independent ombudsman program for investigation of citizen concerns.
  - public awareness and consumer/community involvement in monitoring

The key elements of this model are to introduce an understanding of Disaster Risk Reduction within schools and into the education curriculum, and to identify how procedural tasks, inter-agency task force support and community ownership development are incorporated. These need to be integrated with project prioritisation, design and build tasking, education, contingency preparedness and finance sustainability.[25]

Conclusion

The adverse health effects resulting from the vulnerability of schools and pupils to natural disasters and chemical incidents are apparent from the many previous incidents that have occurred around the world. The issue is not confined to one region, but affects schools everywhere. This vulnerability, and hence the risk of adverse outcomes, can be reduced by systematic development of early warning systems and buildings that are structurally safe. Those who attend and work in schools are key participants in improving health by raising awareness of risks and building a culture of prevention; they are also potential beneficiaries of the reduced vulnerability that results. The World Disaster Reduction Campaign, the International Strategy for Disaster Reduction and the Global Schools Project offers concrete actions to reduce risks in schools at a local as well as national and international level.

References

1 Wisner Ben. The right to safety: Building Safe Schools for Children. UN Chronicle on line edition Volume XLII Number 4 2005

http://74.125.39.104/custom?q=cache:MKNrZTk-LOoJ:www.un.org/Pubs/chronicle/2005/issue4/0405p59.html+Coalition+for+Global+School+Safety&hl=en&ct=clnk&cd=4 (accessed 03.07.08)

2 National Healthy School Standard Report. Reviewing past achievements, sharing future plans. Health Development Agency 2002. Department of Health (accessed 31.07.08)

https://www.nice.org.uk/nicemedia/documents/nhss_report.pdf

3 Thywissen K. Components of risk: a comparative glossary. In Studies of the University: Research Counsel Education. Publication Series of UNU-EHS No. 2/2006 p 39 http://www.unisdr.org/eng/library/Literature/9985.pdf (accessed 07.07.08)

4 Wisner B. Let our children teach us. A review of the role of education and knowledge in disaster risk reduction

ISDR System thematic cluster/platform on knowledge and education July 2006 http://www.unisdr.org/eng/partner-netw/knowledge-education/docs/Let-our-Children-Teach-Us.pdf (accessed 09.07.08)

5 White P, Pelling M, Sen K et al. Disaster risk reduction: a development concern. A scoping study on links between disaster risk reduction, poverty and development. Department for International Development 2004 London http://www.dfid.gov.uk/Pubs/files/drr-scoping-study.pdf (accessed 04.07.08)

6 Williams RM, Murray Parkes C. Psychosocial Effects of Disaster: Birth Rate in Aberfan. . British Medical Journal, 1975, 2, 303-304

7 Morgan L, Scourfield J, Williams D, Jasper A and Lewis G. The Aberfan disaster: 33-year follow-up of survivors British Journal of Psychiatry (2003), 182, 532-536

8 McIntosh DC. West Yorkshire Fire & Rescue Authority. Report of Director of Fire Safety & Community Relations to update Members on the campaign for sprinklers in schools 20 April 2007 http://www.westyorksfire.gov.uk/new/fireAuthority/agendas2006_7/documents/Sprinkler%20Campaign%20Update%20report%20item%2012.pdf (accessed 03.07.08)

9 Head, Fiona (2008) Personal communication, 03.07.08

10 Herbert D. Ofsted report Mayfield School; Unique Reference number 0110666; Local Authority CAMBRIDGESHIRE Inspection number 288734; Inspection dates 23-24 January 2007 http://www.ofsted.gov.uk/reports/pdf/?inspectionNumber=288734&providerCategoryID=4096&fileName=%5C%5Cschool%5C%5C110%5C%5Cs5_110666_20070227.pd

(accessed 04.07.08)

11 Wegelin EA. Facing the environmental challenge, post-tsunami reconstruction In Indonesia Global Urban Development Magazine, Volume 2 Issue 1 March 2006 http://www.globalurban.org/GUDMag06Vol2Iss1/Wegelin%20PDF.pdf (accessed 04.08.08)

12 Gokhale VA Analytical study of living environment in the tsunami affected areas of Tamil Nadu, India ISET Journal of Earthquake Technology, Technical Note, Vol. 42, No. 4, December 2005, pp. 219-225 http://home.iitk.ac.in/~vinaykg/Iset_42_tn2.pdf (accessed 04.08.08)

13 BBC Flood damage delays school starts Wednesday, 5 September 2007, 11:21 GMT http://news.bbc.co.uk/1/hi/education/6979709.stm (accessed 03.07.08)

14 Pitt M learning lessons from the 2007 floods. 1 July 2008 http://www.cabinetoffice.gov.uk/~/media/assets/www.cabinetoffice.gov.uk/flooding_review/pitt_review_full%20pdf.ashx (accessed 03.07.08)

15 Walker A UK-wide vibration monitoring by the British Geological Survey Chemical Hazards and Poisons Report January 2008 11: 12-15

http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1205394722380 (accessed 06.07.08)

16 UNICEF Pakistan Consolidated Emergency Thematic Report October 2005 – March 2006. Pakistan Consolidated Emergency Thematic Report 2005

http://www.unicef.org/pakistan/consolidated_report_to_march06.pdf

17 BBC China quake toll 'to top 50,000' Thursday, 15 May 2008

http://news.bbc.co.uk/1/hi/world/asia-pacific/7402460.stm (accessed 06.07.08)

18 International Strategy for Disaster Reduction web site http://www.unisdr.org (accessed 03.07.08)

19 International Strategy for Disaster Reduction Hyogo Framework for Action 2005-2015:
Building the resilience of nations and communities to disasters

http://www.unisdr.org/eng/hfa/docs/Hyogo-framework-for-action-english.pdf

(accessed 06.07.08)

20 The International Stratefy for Disaster Reduction and its Hyogo Framework for Action (2005-2015): Building the resilience of nations and communities to disasters. Chemical Hazards and Poisons Report September 2008, 13: 40-42

21 Search And Rescue Assistance In Disaster ((S.A.R.A.I.D.). The Global Schools Initiatives Working Together. Sharing Knowledge and Resources http://www.saraid.co.uk/schools/project.doc (accessed 03.07.08)

22 Coalition for Global School Safety (COGSS) http://www.interragate.info/coggs/index.html (accessed 03.07.08)

23 Government of St Kitts and Nevis. Plan to reduce the vulnerability of school building to natural hazards in St. Kitts February 1998 http://www.oas.org/CDMP/schools/sknplan.htm (accessed 09.07.08)

24 Risk RED: Risk Reduction Education for Disasters www.riskred.org (accessed 03.07.08)

25 Wisner B, Bender S, Petal M, de la Pomerai G, Kumar H (date unknown) The Global Schools Project Coalition For Global School Safety'. COGSS

Conference reports

Chartered Institute of Water and Environmental Management and Environment Agency Conference on Critical Infrastructure and Flooding March 26th 2008

Emer O'Connell, Chemical Hazards and Poisons Division, London

A conference to discuss flooding and critical infrastructure was held in March 2008, with delegates from utility companies, emergency services, local authorities, government agencies and public health attending. The aims of this meeting were to:

- Consider the generic implications of the summer 2007 floods for critical infrastructure.
- Consider the perspective of the numerous sectors managing critical infrastructure in responding to the challenge.
- Review the generic responses needed to address threats to critical infrastructure.
- Allow delegates to share information to help them to respond to the Pitt Review.

Delegates were welcomed to the full to capacity conference venue by David Rooke, Head of flood risk management at the Environment Agency (EA) and acting President of the Chartered Institution of Water and Environmental Management (CIWEM).

Dr Chris Digman, from MWH Consulting presented an overview of extreme rainfall events, including a consideration of the different types of flooding caused by different types of rainfall: pluvial flooding, which can occur due to overwhelmed drainage systems and often follows short-lived intense rainfall events, and fluvial flooding, which is often the result of long periods of rain resulting in saturated soils and increased runoff. Flooding defences will not protect against localised pluvial flooding so some other approach is required for this form of flooding and these options must be explored. Extreme event flooding has occurred regularly in the UK, and these events are predicted to increase in their frequency. Therefore, pro-active management of flooding and the impacts of flooding are required alongside measures taken to mitigate flooding.

Paul Davies from the Met Office introduced the developments in weather forecasting and their impact on predicting extreme rainfall. The Met Office currently has two major areas of research with direct relevance to flooding. High resolution forecasting aims to improve the precision of the forecast and will hopefully improve the ability to predict weather events in any locality. Probability forecasting aims to improve the estimates of 'how likely' it is that any forecast event will take place.

Colin Berghouse, from the Department of the Environment Food and Rural Affair's (Defra's) Flood Emergencies Capability Programme, presented his thoughts on building resilience into local services and argued that resilience comes not just from emergency planning but should also include business continuity arrangements and investment in critical infrastructure. Although emergency plans during the summer 2007 proved to be effective generally, in many instances there was little resilience and there were challenges to managing the consequences of the floods. He also highlighted the challenges that arose during the flooding 2007 with trying to share data and information about sensitive infrastructure. All Category 1 responders should be given information on the critical infrastructure in their area; however, in practice this can be difficult as there are limited data available and some of it is commercially sensitive. There are additional issues as to how we define 'critical'; a relatively small resource may be critical at the local level, for example, a local post office in a rural town. He added that individuals have the right to know whether they are at risk to allow them to protect themselves adequately.

David Gibson presented a very rousing review of how Hull Local Authority managed the flooding event and its aftermath. The region had never experienced a natural disaster on the scale of the flooding in 2007, and due to the pressure on their resources, the Council implemented a prioritisation system for supporting residents of the city; this was a needs-based system, applied across the population regardless of whether tenancy was council- or privately-owned. In the long-term, Hull is vulnerable to tidal flooding and due to its low elevation and subsequent reliance on pumping drainage, Hull also has very limited natural drainage. The Council has employed a review body to examine why the flooding took place in 2007 and the outcomes of this Review will inform the Council on how best to improve their response to flooding, including improvement of the drainage systems and flood defence, improving the way they manage water in the city and how they plan and construct new developments.

Eddie Coventry presented his experience of the flooding 2007 as a member of the Emergency Management Service for Gloucestershire County Council. Although they had received a forecast for heavy rain and potential flooding, within 4 hours they were utterly flooded, leaving little time for them to react. He highlighted the logistical difficulties with managing the disruption and dislocation of the transport infrastructure, the loss of mains drinking water – in some instances, for a prolonged period of time – and preparing for the potential loss of mains electricity. There were concerns over potential public disorder following the disruption of the water supply; the legal requirements for alternative supplies does not provide an adequate volume or supply over a long period of time, such as is likely to result from flooding of a water treatment plant. On a more positive note, Mr Coventry added that multiple agencies collectively responded to the demand for water and that the media in this instance were helpful. He suggested that response capabilities for long-term events have to improve, as does community resilience. Planning for the consequences of events of this kind is difficult and the Council have found it difficult to get information from utilities about likely outcomes in the case of failure; it may require government intervention to force utilities to share this kind of information with responders.

Andy Hirons from National Grid presented an overview of their response to the flooding in 2007 and their plans for improving their response in the future. They have reviewed the vulnerability of their infrastructure and are working with the EA to identify areas of risk and to develop short/medium/long-term flood response strategies. As power stations require water for cooling, many of these are purposely built beside rivers, with substations nearby, making them prone to flooding. As part of their short-term response, National Grid have invested in flood defences and have installed additional protection to those sites that were affected by flooding in 2007. They are also working to identify their point failure spots so as to allocate resources accordingly if these are threatened.

Dr Jim Marshall from Water UK presented some of the findings from the Water UK Flooding Review Group, which evaluated the industry's response to the summer floods of 2007. The main recommendations from Phase 1 of the Review Group were that water companies should review their emergency response and contingency plans to include scenarios where the scale of future events may be greater than those considered in their current plans. Future plans should review the potential vulnerability of their key assets, including the risks from other key utility service failures. Phase 2, which will look at the longer term issues, is currently underway and this will include an evaluation of the potential vulnerability of infrastructure and services to climate change, public expectations about the reliability of supply and reduced risk, and the responsibility of the water companies for flood prevention and remediation.

Emma Johnson from Water Asset Management at United Utilities presented her views on the criticality assessment of water. Some of the communities affected by the summer flood in 2007 felt that the loss of mains water was the most difficult aspect of the flood to cope with. It is essential that access to water is maintained and this should be covered in the emergency plan of each water company; however, in the longer term, the aim must be to protect water infrastructure from such flooding in the first place. United Utilities are developing a strategy to increase the resilience of water facilities to flooding events including: methods to identify water facilities at risk, using GIS spatial analysis; details of the infrastructure that are at risk of flooding and potential resilience measures; a 'time to recovery' study of wastewater treatment plants post flooding; defining and identifying critical facilities in terms of the population affected by a loss of supply; and cost benefit analysis to support capital investment in flood resilience measures.

Ian Hope from the EA presented issues related to potential failure of reservoirs. The EA is the enforcement authority in England and Wales for the Reservoirs Act 1975; this legislation places duties on the dam owners to reduce the risk of an escape of water from a reservoir. Prior to the near flooding of the Ulley reservoir in June 2007, there was little information on the risks associated with reservoirs. However, the failure of a reservoir could result in catastrophic flooding with significant loss of life and damage to infrastructure. Under the Water Act 2003, flood plans for reservoirs are expected to become a legal requirement from Spring 2009; it is hoped that these plans will include maps and will inform emergency planning and mapping risk for critical infrastructure.

Santi Santhalingham is a Principal Drainage and Water Quality Specialist with the Highways Agency (HA). He presented an overview of the HA approach to climate change adaptation and flood mitigation. Although the Strategic Trunk Roads (STRs) account for only 2% of the overall UK roads network, they carry a third of all traffic and two thirds of all freight. Following the flooding in summer 2007, the HA conducted a review of its response to the incident, including the publication of lessons learned and recommendations for action. The HA has been tasked under a number of recommendations in the Interim Pitt Review, and a number of these had already been put in place prior to the publication of the Pitt Review.

Zoe Hutchinson presented on the various types of National Rail infrastructure that can be affected by flooding and issues relating to linear assets on flood plains.

Steve Coupe, a Senior Manager with the EA, presented some of the results from the EA Flood Mapping Strategy 2003 – 2008, including the Receptors Vulnerable to Flooding Database (RVD). The RVD covers England and Wales and can be used to produce 100m x 100m grid of summary information, aligned with the OS national grid. The RVD was constructed using three basemaps: a social vulnerability map; a building flood vulnerability map; and a land cover flood vulnerability map. Even before the flooding in summer 2007, the added value in linking the RVD with the National Flood Risk Assessment to identify critical receptors in flooding events had been identified and three further linked datasets were added: critical infrastructure; London Underground stations; motorways and A roads. The Environment Agency is continuing their risk mapping work with the National Flood Risk Assessment 2008.

Conclusion

This meeting was over-subscribed; hopefully this indicates a broader acceptance of the importance of protecting and improving the resilience of UK critical infrastructure to flooding. A number of key messages came out of the meeting, including:

- Category 1 responders must be given enough information about the critical infrastructure in their area, at the moment the existing data is limited and of questionable accuracy.
- Emergency plans need to consider secondary and tertiary consequences of failures.
- There is a need to identify potential single points of failure and ensure that these are resilient.
- Business continuity and emergency plans must be developed in parallel, with the aim of reducing incidents as well as managing consequences.
- Even with accurate forecasting, there may be a very short time period between when the rain starts to fall and when the flooding is so severe that putting any reactive systems in place becomes very difficult. Emergency services may be overwhelmed very quickly.
- There is a need to improve our understanding of surface flooding, and to streamline the management of surface water channels.
- Night-time temperatures were luckily not an issue during the summer 2007 flooding; however, future incidents may occur in colder temperatures and this will have significant implications for protecting the health of the communities affected.
- Loss of critical infrastructure, such as water and electricity supplies, may result in a need to evacuate large communities. This is not a decision that can be made lightly, and it is important to remember that a proportion of people will not leave their homes, even when advised to do so.

Water Contamination Emergencies Conference - Collective Responsibility, 7 – 8th April 2008 at the Royal Society of Medicine, London

Martin Furness[1] and Dr. John Gray[2]

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We take drinking water quality for granted in the developed world and consumers expect absolute safety 24/7. The UK Water Industry has an excellent drinking water quality record, yet history shows there have been significant challenges to potability during specific water quality incidents. Furthermore, with many countries now concerned that water supplies could be a possible terrorist target, preserving drinking water security is an increasing priority.

The third in a series of international conferences on water contamination was held on 7-8 April this year at the Royal Society of Medicine. As with the previous conferences, attendees came from water companies, the public health community, research organisations, regulatory agencies, academia and treatment and monitoring suppliers. Delegates joined speakers, exhibitors and organisers for what proved to be a very successful two-day conference. There were 167 attendees from 15 different countries to hear 47 presentations.

This third conference had as its theme 'Collective Responsibility'. Quoting the organising committee Chairman, Dr John Gray, "As well as organisations clarifying and understanding their responsibilities, it is our belief that individuals should also identify their own key responsibilities and take action to establish effective and efficient working relationships and knowledge-sharing networks with those with whom they will be required to work in an emergency – in other words, taking Collective Responsibility".

In organising the conference, the organising committee aimed to provide a forum where those key organisations which would be actively involved in responding to any water contamination incident could share knowledge and experience. It was considered that collective responsibility required prior consideration of how to plan, respond, communicate and manage risk in an emergency and how to share, learn and develop after the event. It was questioned whether individuals and teams learned, shared best practice, had effective and established networks, collaborated, targeted research or exercised together. There appeared not to be a common set of values for evaluating risk and prioritising risk and a constrained enthusiasm and desire to make a common approach work. There also appeared to be little opportunity to modify systems. By encouraging international involvement, it was hoped that broader networks to promote these objectives would be established.

At the first Conference in 2002 in Kenilworth, Warwickshire, delegates were challenged with the question, 'Can We Cope?'. The conference focussed on the more traditional type of water quality incidents that have occurred over the years. Generally, it was felt that water companies and the key agencies had responded well, but more awareness and pre-planning would be beneficial. The second conference in 2005 in Manchester sought to address the theme of 'Enhancing Our Response'. New technologies and practices being developed to improve preparedness and responsiveness were identified and presented. At this second conference, issues associated with CBRN incidents were identified, which would generate significant potential challenges. Again, there was evidence of progress in preparedness, both in the UK and internationally. There was also a desire to see more interaction between key players responding to water quality incidents to develop improved procedures and provide learning opportunities. This led directly to the organising committee identifying the theme of this third conference – 'Collective Responsibility'.

In order that the widest possible range of subjects could be offered, presentations were selected for three streams: Operations (systems, security and procedures); Data/Information (quality testing, analysis, on line monitoring, modelling and data interpretation); and Communication (emergency planning, public communication and inter agency working). Each stream began with planning and preparedness, followed by security and initial responses and incident management and the aftermath. The conference ended with three plenary sessions - "Best practice", "Lessons Learned" and "The Way Forward".

Organising committee Chairman, Dr John Gray, opened the conference by setting the scene and linking the two previous conferences and their outputs to this third one.

The first plenary presentation was given by Dr Gordon Nichols, HPA, who described the aims of the Conference within the context of past microbiological incidents and what they should have taught us. Adverse weather conditions were main factors in 28% of water contamination incidents. Topics mentioned included: planning and preparedness; security and initial responses; HPA incident management; the Summer Floods; and the importance of regular contact between water companies and Health Protection Units.

The Operations stream reported how Water Companies in different countries tackle asset security, risk management, system monitoring, bottled water provision and decontamination actions. The function of command and control structures was discussed in several presentations, and the necessity for integrated strategic management.

The Data/Information stream looked more closely at the measurement of water quality in live water supply systems, as well as the use of novel chemical and radiological screening methodologies for emergency incident samples, rapid sensing technologies to detect contaminants and micro-organisms, and the management of radiological incidents. The Buncefield fire was discussed in terms of the resulting environmental impacts, which

required significant data capture, and the publication of handbooks for managing radiological incidents was also considered.
The Communications stream considered approaches to Emergency Planning, water security initiatives, liaison with the HPA and health professionals, means of communicating key messages to different groups of consumers, and the legal implications of a major incident. The role of Chemical Hazards and Poisons Division in advising teams dealing with incidents and emergencies and the reporting of notifiable incidents was presented, as well as the function of a Scientific and Technical Advisory Cell (STAC), the Incident Control Team model, and the available information websites that medical and public health practitioners may use to help deal with water contamination incidents.

The final sessions in the conference sought to bring together best practice and learning from lessons to stimulate delegate discussion.

An informative insight was given regarding what actions would take place if a terrorist-related incident was to occur. This included the high operational tempo, command and control structures, intelligence effort, media strategy and multi-agency working. There was also a timely reminder that there is published literature "out there" describing the deliberate contamination of water supplies. Finally, an historical background was presented on key water contamination incidents and resulting lessons learned. This was then put to the audience as a challenge to stimulate discussion with the aim of promoting the value of effective networks to share best practice, to undertake training and exercises, and to provide a structured process for lessons to be cascaded to all practitioners.

Dr John Gray concluded the conference. He reminded the audience that the conference had sought to show how we all plan, communicate and manage risks for water contamination incidents and share, learn and develop following an incident. Finally, he challenged the delegates and the water industry at large to put real actions in place and take the identified issues forward to completion, notably the sharing of lessons. His parting words were chosen to stimulate internal reflection in the delegates, to remove any lingering complacency, and continue the move to more harmonious and inclusive inter-agency working:

"Are you that good that others want to work with you?"

The UK water industry can be proud of its drinking water quality; a matter of public record. Consumers can continue to be reassured that water companies and all relevant agencies are constantly reshaping practices and procedures to keep it so.

Further information on the proceedings can be obtained from the authors.

Our Coast and Health Conference 2008

Eirian Thomas, CHaPD South West
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For thousands of years people have chosen to live on the coastline to enjoy the well being of its environment and the harvest of the sea. Modern life has altered our basic need for food and shelter but the attractions of the coast remain. Each year tourists spend 26 million nights in the South West of England and contribute significantly to its culture and economy. There is a need therefore to create a greater awareness of the issues and challenges faced by coastal communities.

A conference aimed specifically at these communities was held on 28th and 29th April 2008 in Plymouth. The South West 'Our Coast and Health Conference 2008' sought to attract delegates within the field of tourism and marketing, public health, environmental science and engineering who share a common interest in the coast.

Natasha Barker from Cardiff University gave the key-note address on Integrated Costal Zone Management (ICZM). This is a national and international initiative to bring together all those involved in the development, management and use of the coastline within a framework that facilitates the integration of their interests and responsibilities. The objective of ICZM is to establish a sustainable level of economic and social activity in our coastal areas whilst protecting the coastal environment.

Natasha drew on her experience of being involved with ICZM projects funded by Department for Environment, Food and Rural Affairs (DEFRA), the Department for International Development (DFID) and the British Council involving European Countries and former Soviet Union States. The summer floods of 2007, marine pollution incidents and the drive for renewable tidal and offshore energy were cited as examples where no single agency or organisation can work alone. Delegates were encouraged to consider how they could work with others to deliver a more integrated approach to coastal management.

Over the two days, government agencies, academic institutions and others came together to hear from a variety of speakers on the following five themes:

- Public health
- Marine pollution
- Sustainability and climate change
- Science, evidence and policy
- Renewable energy

The full conference programme, abstracts and copies of presentations can be found on the HPA Document Gateway website (https://dgw.hpa.org.uk/login.spl) using the following access details: Username – *Coastalconference*, Password: *bournemouth*
Of particular public health interest was a presentation by Professor Liz Meerabeau from the University of Greenwich, who reported on the findings of a French-British European funded project examining health inequalities and health behaviour in South East England and France. The results show that whilst the English seaside has been traditionally viewed as health giving, where resorts lose their holiday status there is a downward spiral, creating a new excluded community of low income households, thus presenting new challenges for policy makers.

Dr Ann Plamer from the Centre of Health Service Studies, University of Kent noted that further analysis of a study in Kent and Medway examined the link between socio-economic deprivation and mortality and found a variation in expectancy of life by 2 years between wards on the coast and wards inland in some coastal towns. This was specially marked for cancers, less so for coronary heart disease.

In contrast, on the second day of the conference Peter Cole, Regional Strategy Director for Tourism in Cardiff was able to highlight the economic benefits and some of the environmental impact and value of tourism in Cardiff. The presentation gave an overview of the development of Cardiff Bay over the last decade and the importance of the barrage to the overall regeneration project. Some of the principles of this project are now being applied to other tourism initiatives in the South Wales Valleys to increase economic prosperity.

This illustrates the importance of understanding the complex issues that affect the health of people living in coastal areas and some of the opportunities that exist to influence economic development and prosperity.

Dr Sue Bennett, Director of Dorset and Somerset Health Protection Unit presented on the public health impact of the sinking of the MSC Napoli, with the aim of raising awareness of the interagency working associated with the largest UK marine salvage operation to date. This was followed by a presentation by Professor Tamara Galloway who described how a joint project between the Environment Agency and Exeter University assessed the environmental impact of the same marine incident. This work demonstrated the importance of developing links between government agencies and academic institutions and the benefits that can be gained from partnership working.

During the forum session at the end of the conference it was agreed that the conference provided an ideal opportunity for areas of mutual interest to be identified and promoted. However, it was felt that more could be made of this if organisations worked on an ongoing basis to develop a common understanding of the issues. It was agreed that a number of regional workshops would be organised to develop a variety of work streams identified at the conference. These would then feedback to the next South West coastal conference planned for 2010.

Following a stimulating day of presentations and discussion delegates were invited to attend an evening reception and take a tour of the Plymouth Marine Aquarium. The conference dinner was served in front of the Atlantic Reef tank, which is home to 10 species of shark, providing what has been described as the most spectacular dining room in the South West.

The Health Protection Agency would like to thank the following organisations for their support in organising the conference: Plymouth Marine Laboratory, South West Tourism, Environment Agency, South West Public Health Observatory, NHS South West, Peninsula College of Medicine and Dentistry.

4th UK and Ireland Meeting on Occupational and Environmental Epidemiology St. Alban's Centre, London 7 July 2008

Prof. Damien McElvenny[1], Dr Lesley Rushton[2]
1. University of Central Lancashire
2. Imperial College, London

This meeting provides an opportunity for all who are active in research in occupational and environmental epidemiology in the British Isles to showcase their work. The aim is to restrict the meeting to single day and for the cost of registration to be a low as possible. As well as an opportunity for senior researchers to network, posters are particularly encouraged from junior and pre-doctoral researchers.

This year's meeting, which was organised by the University of Central Lancashire, opened with Richard Wakeford from the University of Manchester providing an overview of current issues in the occupational and environmental epidemiology of ionising radiation. Richard explained how current radiological protection limits are based on epidemiological studies of the survivors of the Japanese atomic bombings at the end of the Second World War and of patients therapeutically and diagnostically irradiated. Richard explained that direct observation of workers in the nuclear industry would replace these studies when follow up was sufficiently long, although studies of workers involved in nuclear weapons programmes, who tended to have had the highest doses, often had their risks diluted in international studies by workers in the power generation industry who tended to have lower doses and whose follow-up tended to be shorter. Richard explained the current interest in non-cancer effects in the nuclear industry, although there was little evidence from animal data for there being a plausible mechanism for such effects to occur at doses received by workers in the nuclear industry.

Tom Sorahan from the University of Birmingham gave an insight into a recent paper he had published containing a "lugged" analysis of workers exposed to carbon black. Tom explained that often epidemiologists are interested in assessing whether a particular exposure is an early stage carcinogen (often by lagging the exposure to exclude most recent exposure). He posed the question as to how to do an appropriate analysis that was trying to look for the effects of a late stage carcinogen i.e. due to more recent exposure. He suggested that if the lagged exposure was subtracted from the total cumulative exposure, then the remaining exposure could be regarded as lugged and that an effect caused by such an exposure pattern could be regarded as being consistent with a late-stage carcinogen. Although the data from the carbon black analysis were not convincing, it was suggested that studies involving workers exposed to metals might provide a data set where a lugged analysis would provide reasonably convincing evidence of a late-stage carcinogen.

Keith Palmer from the MRC Epidemiology Group at the University of Southampton gave a presentation highlighting that earlier findings from an analysis of national death certificate data for an association between exposure to metal fume and increased risk of pneumonia persisted in an analysis of the most recently-available data. The risks are not restricted to welders, but are seen in other metal workers. The pneumonia is mainly lobar in those aged less than 65 and the risks are reversible if exposure ceases. It was suggested that this disease could potentially be assessed for recognition as a prescribed disease under the industrial injuries benefit scheme. Two possible biological mechanisms are currently under investigation.

Dave Gee from the European Environment Agency gave a thought-provoking presentation on why different international committees assessing the same set of data might come to different conclusions regarding causal associations. His contention was that committees often waited for too much evidence to be accumulated before concluding that an association was causal and that the rationale for their conclusions was often not clear. It was his view that more credence should be given to the precautionary principle and that policy makers should err on the side of caution. The clearest example of this was the observation of health effects in relation to asbestos which were first recognised at the end of the 19th century, but it was towards the end of the 20th century before the banning of the manufacture of asbestos-containing products in the UK. He recommended that epidemiologists should re-read the seminal 1965 publication by Sir Austin Bradford Hill on causality criteria, and not to apply them too rigidly.

During the meeting, 19 posters were presented with the authors giving a two minute presentation of the salient points from their work, with questions from the audience. Subjects ranged from analysis of asbestos- and pesticide exposed workers, through to an international study of musculoskeletal disorders, analyses of a possible cancer cluster around mobile phone masts, and an examination of a cluster of skin disease among staff and pupils at a school near a chemical complex. Prizes for the best posters were awarded to A Shirangi of Imperial College for her analysis of occupational hazards associated with preterm delivery in female veterinarians and to Jo Szram, also from Imperial College, for her examination of whether FEV1 predicts capacity to work in an ageing population.

The 4th UK and Ireland meeting on occupational and environmental epidemiology was sponsored this year by the Health & Safety Executive, the Health Protection Agency and was underwritten by the Colt Foundation. Advertising was provided by the International Society for Environmental Epidemiology and the University of Central Lancashire. Damien McElvenny, from the University of Central Lancashire, and Lesley Rushton, from Imperial College London, acted as Co-Chairs for the meeting.

Training Days for 2008-09

The Chemical Hazards and Poisons Division (CHaPD) considers training in chemical incident response and environmental contamination for public health protection a priority. The 2008-09 programme is being developed to offer basic and more detailed training, along with the flexibility to support Local and Regional Services initiatives as requested.

Planned one day training events for 2008 include:

Contaminated Land

Postponed until further notice

For Consultants in Health Protection, CsCDC, CsPHM and Specialist Registrars in Public Health Medicine and Local Authority Environmental Health Officers

The Training Day will provide delegates with the tools and information to provide an appropriate and timely Public Health response to contaminated land investigations.

General aims:

- To understand the role of public health in the management of contaminated land investigations.
- Awareness of the appropriate and timely response to contaminated land investigations
- To understand the interaction with other agencies involved in the investigation and management of contaminated land.
- To review current issues relating to the management of contaminated land incidents and investigations including:
- The Toxicology of Soil Guideline Values
- The Local Authority Perspective on Implementing Part II A
- Bioaccessibility in Risk Assessment
- The Food Standards Agency (Allotments)

Specific objectives:

To understand by using incident examples the process for public health response to contaminated land issues.

To understand by using examples and case studies the type of information and the limitations of the risk assessment models provided to public health from other agencies regarding contaminated land.

To understand by using incident examples the roles and responsibilities of the different agencies involved in investigating and managing contaminated land.

A maximum of 40 places are available

Level 2 Chemical Incident Training

24th November, Manchester

For Consultants in Health Protection, CsCDC, CsPHM and Specialist Registrars/Trainees in Public Health

The chemicals training programme aims to train HPU and LaRS-regional HPA staff to achieve 'Level 2' competence for the management of chemical incidents and to meet the requirements of the Health Care Commission relevant to preparedness and response to chemical incidents (core standard 24).

The learning objectives are:

- To demonstrate an understanding of the roles and responsibilities of Health Protection in the management of chemical incidents.
- To demonstrate an understanding of the roles and responsibilities of other agencies involved in chemical incident management, and how they interact with Health Protection.
- To understand the principles of risk assessment, biomonitoring, environmental sampling and modelling, and their application in the investigation and management of a chemical incident.
- To understand the principles of communication and management where there are unresolved public concerns in environmental incidents.

Training Programme for 2008-09

How to Respond to Chemical Incidents

30th October and November (TBC), London

For all on the on-call rota including Directors of Public Health and their staff at Primary Care, other generic public health practitioners, Accident and Emergency professionals, paramedics, fire and police professionals and environmental health practitioners

The general aims of these basic training days are to provide:

- An understanding of the role of public health in the management of chemical incidents.
- An awareness of the appropriate and timely response to incidents.
- An understanding of the interactions with other agencies involved in incident management.

These training days also have specific educational objectives. These are, to be aware of:

- The processes for health response to chemical incidents.
- The type of information available from CHaPD, London to help the health response.
- The resources available for understanding the principles of public health response.
- The training needs of all staff required to respond to chemical incidents.

A maximum of 40 places are available

Operational Lead Workshop

6th November, London

This day is aimed at local authority Environmental Health Practitioners, but will also be of interest to public health and health protection professionals.

The day will focus on the operational environmental public health response to cases of lead toxicity, including:

- Roles and responsibilities of local authorities & environmental health, public health & health protection, and other partners
- Lead 'action card' for Environmental Health Practitioners
- Environmental investigation for lead
- Biological sampling
- Legislation for the investigation and management.

Please see the website for further information, or contact Karen Hogan.

Training Programme for 2008-09

Planned one week training courses include:

Essentials of Environmental Science

10-14th November 2008, King's College London

This course is designed for those working in public health, health protection, environmental science or environmental health and who have an interest in or experience of environmental science and public health protection and would like to develop their skills

The aims of this short course are to summarise the key concepts of environmental science, the study of the physical, chemical, and biological conditions of the environment and their effects on organisms. The course will concentrate on the basics of environmental pathways - source, pathway, receptor – and consider the key issues in relation to health impacts of air, water and land pollution and the principles of environmental pollutants and impacts on health. Environmental sampling will also be covered: its uses and limitations for air, land and water, leading to a consideration of environmental impact assessment and links to health impact assessment. Awareness of the main environmental legislation will be provided along with an understanding the process of determining environmental standards, what standards are available, how to access them and how to utilise them. Sessions will be based upon examples of incidents associated with health protection which may lead to adverse health effects. The course will also provide an overview and understanding of the advantages and difficulties of multi-disciplinary and multi-agency working in environmental science, and the use of strategies for communicating risks associated with the investigation of this science. The fee for this course will be around £600.

Participants will receive a CPD certificate, or may elect to submit a written assignment and take a test to receive a formal King's College London Transcript of Post Graduate Credit.

A maximum of 30 places are available.

Introduction to Environmental Epidemiology Short Course

16-20th February 2009, London School of Hygiene and Tropical Medicine

This course is designed for those working in public health, health protection or environmental health and who have an interest in or experience of environmental epidemiology and would like to improve their skills

The aims of this short course are to summarise the key concepts in environmental epidemiology, to explore the key concepts in exposure assessment and cluster investigation, to examine the scope and uses of environmental epidemiology in local agency response to public health and health protection issues. Also it will show how to explore study design and the practical consequences of choices made when planning and undertaking an environmental epidemiological study. This will include an appreciation of the influence of finance, politics and time constraints on the choice of study, to review the advantages and difficulties of multi-disciplinary and multi agency working in environmental epidemiology and to use strategies for communicating risks concerning investigation of environmental hazards. The fee for this course will be around £600.

Training Programme for 2008-09

Essentials of Toxicology for Health Protection

June 2009, King's College, London

This course is designed for those working in public health, health protection or environmental health and who have an interest in or experience of toxicology and public health protection and would like to develop their skills

The aims of this short course are to summarise the key concepts in toxicology and of toxicological risk assessment, exposure assessment and to examine the scope and uses of toxicology and the tools of toxicology in local agency response to public health and health protection issues. Sessions on toxicology will be based upon examples of incidents associated with health protection which may lead to adverse health effects. This course would provide an understanding of the limitations resulting from the lack of data on many chemicals, chemical cocktails and interactions. The course would provide an overview of all these aspects to provide an understanding of the advantages and difficulties of multi-disciplinary and multi-agency working in toxicology and the use of strategies for communicating risks associated with the investigation of toxicological hazards. The fee for this course will be around £600.

Participants will receive a CPD certificate, or may elect to submit a written assignment and take a test to receive a formal King's College London Transcript of Post Graduate Credit.

A maximum of 30 places are available.

Please see the CHaPD Training Events web page for regular updates: **http://www.hpa.org.uk/chemicals/training.htm**

Booking Information

Those attending CHAPD (L) courses will receive a Certificate of Attendance.

The cost of the training days are £25 for those working within the Health Protection Agency and £100 for those working in organisations outside the Health Protection Agency. Places will be confirmed as reserved upon receipt of the fees. These charges are to cover lunch, training packs and administration costs.

For booking information on these courses and further details, please contact Karen Hogan, our training administrator on 0207 759 2872 or chemicals.training@hpa.org.uk

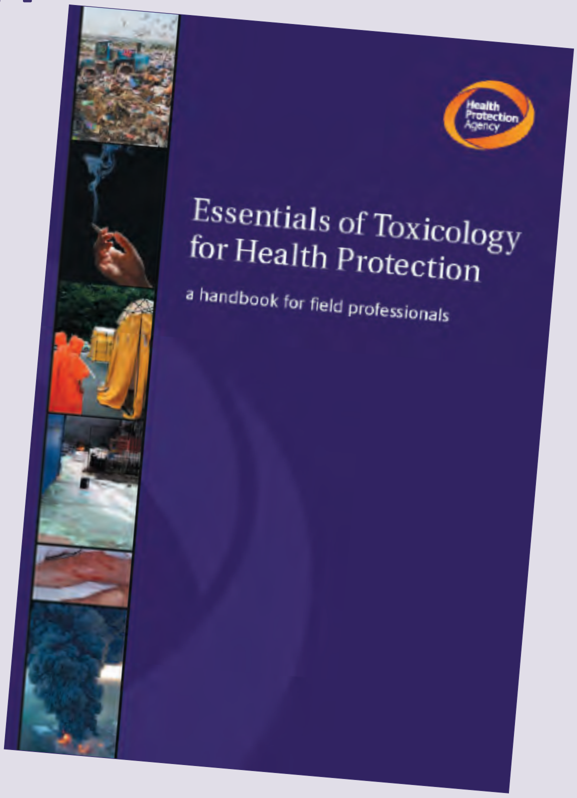
CHAPD (L) staff are happy participate in local training programmes or if you would like training on other topics, please call Virginia Murray or Karen Hogan to discuss on 0207 759 2872.

Events organised by other HPA centres

If you would like to advertise any other training events, please contact Karen Hogan (chemicals.training@hpa.org.uk).

Essentials of Toxicology for Health Protection

a handbook for field professionals



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- the water and waste industries
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Section 1 - **Fundamentals of Toxicology**
provides a general introduction and explains how toxicological information is derived.

Section 2 - **Applications of Toxicology**
considers exposure assessment, susceptible populations, the medical management of chemical incidents, and sources of toxicological data.

Section 3 - **Environmental Toxicology**
considers pollutants in air, water, and land, food contaminants and additives, and exposures to toxic agents in the workplace.

Section 4 - **A Review of Some Toxic Agents**
discusses a selection of important toxic agents: carbon monoxide, pesticides, heavy metals and trace elements. It also considers traditional medicines and the deliberate release of toxic agents.

A chapter on basic medical concepts and a glossary are included as appendices for those readers who don't have a background in medicine, biology or the health sciences.

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