Health Risk Perception and Environmental Problems:
Findings from ten case studies in the North West of England
Summary Report
Paolo Luria, Clare Perkins, Mary Lyons
May 2009
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Foreword

I am grateful for the support and expertise from Dr Luria and his colleagues at the Centre for Public Health, Liverpool John Moores University for producing this report that will be of enormous assistance, not only to public health professionals, but indeed anyone whose role means that they actively engage with the public around any of the wider determinants of health. The project was delivered as part of the annual workplan we agreed for the Health Protection Agency’s environmental and chemicals team that brings together colleagues across the three Health Protection Units in the region, and those based from the chemical hazards and poisons division. The region has a strong heritage and legacy of old industrial sites, that together with issues emerging in more recent years has led to significant environmental health hazards. We aim to investigate thoroughly all credible health hazards and analyse the possible linkages between human populations and any potential or suspected health effects. We are aware however that public perception may not fully coincide with views of scientists and professionals, and this may pose a challenge to effective engagement and communication with our local communities especially when offering information and advice on prevention or control and reassurance where applicable. We aim to review key incidents and issues that emerge from our work, to help us develop improved responses and closer relationships with partners in the region. We also seek to share our lessons on good practice more widely in the Health Protection Agency and elsewhere. We work closely with our partners in Primary Care Trusts, Local Authorities, the Environment Agency and many others to develop a good scientific understanding of environmental issues and to investigate any potential exposure pathways to humans and whether any associated health effects can be determined. I am grateful to the team who have performed this review and also to all our partner agencies and stakeholders who have provided information and input at any stage to these ten case studies.

Prof John A. Reid
Chair of Environmental and Chemical Team, HPA North-West Region
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- David Neary, Public Health Researcher
- Jane Harris, Research Assistant

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- Sian Morrow, formerly Scientific Officer at the Environmental Health Service - Salford City Council - now Environmental Public Health Scientist, Chemical Hazards and Poisons Division Birmingham (Manchester)
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1. Risk perception may be more important in determining priorities for health promotion and intervention than calculated risk of illness or injury.

2. Concern about a potential environmental health hazard can affect mental, physical and emotional well-being; but is often not taken seriously enough by professionals; especially if the position adopted by members of the public appears to be illogical or extreme.

3. The professional response to public concern about a potential environmental hazard usually involves a quantitative investigation to determine the extent of any physical health risks to justify concerns and then communicating this to the public.

4. Estimation of community anxiety and stress should be included as part of every risk or impact assessment of proposed plans that involve a potential environmental hazard. This is true even when the physical health risks may be negligible.

5. Public reaction to an environmental hazard relates more to the feared consequences of exposure, rather than the likelihood of exposure.

6. The health and social effects of anxiety and stress arising from awareness of a potential environmental hazard are not systematically reported nor easily measured. Their significance may not be obvious to regulatory bodies that tend to focus on the technical and legal aspects of any investigation.

7. A 'precautionary approach' gives regulatory bodies confidence, but may highlight knowledge gaps and trigger new concerns (i.e. the public may overreact to precautionary measures justified by uncertain but still negligible risks).

8. Unfamiliar or incomplete information may lead people to form their own inaccurate though 'consistent' mental picture of the situation.

9. Inadequate communication about a new proposal or environmental hazard can invoke anger in the community.

10. Risks associated with new technology are usually considered less acceptable than natural risks.

11. Regulatory bodies are not always trusted by the public.

12. In general, the use of statistics is not the best way to communicate about risk with members of the public.
Introduction

Public concern over any environmental health hazard may produce significant effects on the mental, physical and emotional wellbeing of the local population (Barnes et al, 2005; Bridgman, 1999; Tapsell & Tunstall, 2007; Reacher et al, 2004).

Today, many organisations acknowledge the fundamental contribution of risk perception and communication to risk management. Professionals are expected to take a holistic approach; to understand the needs of the community; effectively communicate with individuals and groups; and involve the public in any relevant risk assessment.

Aims

This work aims to provide anyone who has some responsibility for the wider determinants of health with a useful tool to assist in the management of public concerns that arise from potential environmental hazards.

In particular, it:

- **a)** identifies and explores environmental health hazards using a case study approach
- **b)** compares public perception of the level of risk posed, with best evidence available about known health risks associated with each hazard
- **c)** provides evidence for appropriate communication activities; and lists resources that will help public health practitioners understand community concerns and develop strategies to manage environmental risks

This work does not intend to prove any particular hypothesis on risk perception, nor does it include any primary survey data. It is designed primarily to support organisations in the North West of England, who are dealing with local groups and communities on a daily basis. The findings from the case studies may well have national or international relevance. However, since risk perception is essentially an expression of local culture, lessons learned may not be universally applicable.

Although risk communication is very important, it is not considered specifically in this work which focuses primarily on risk perception. Noteworthy scientific literature and official guidance about how practitioners should communicate with the public is already available, e.g. Bennet (1997), UK Resilience (2006) and House of Commons Science & Technology Committee (2006).

Structure

Each case study includes a commentary on the most important concepts that may be helpful in understanding the health and social problems arising from the public perception of the particular hazard, the authorities’ response and an outline of what happened next.

Each set of studies is followed by a commentary providing evidence and key points to consider and apply in similar situations.
The areas of public concern investigated in this study were determined by a steering group of public health specialists and practitioners, including representatives with considerable professional experience from each of the three Health Protection Units in the North West who deal with these issues on a daily basis.

A number of primary care trusts and environmental health officers in the region were also contacted by email or by telephone and asked to provide information on the selected case studies involving the topics shown in Table 1 below.

### Table 1: Areas of concern investigated through this work

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The full report is available at [www.cph.org.uk](http://www.cph.org.uk) It contains a list of references organised both by author and topic, to facilitate the search for useful resources on each specific topic.
Case studies

Case study 1: Ince Resource Recovery Park – Ince Marshes, Cheshire

Description
In February 2006, a private company presented two planning applications for construction of waste recycling plants on Ince Marshes, an area of around 100 hectares of wetland, surrounded by industry that lies to the east of the village of Ince, in Cheshire. One application was for a resource recovery park and the other for a refuse derived fuel (RDF) plant. The latter was intended to incinerate 600,000 tonnes per year of RDF to generate over 95MW of electricity.

Public risk perception
This proposed project soon provoked strong public opposition and by August 2006, around 2,000 letters of complaint were received by the local authorities. The majority of concerns were about the proposed incinerator and any potential harmful emissions.

Authorities’ response
The Directors of Public Health established a steering group that undertook a rapid health impact assessment (HIA). This focussed on health profiling the community and exploring perceived health impacts through analysis of complaints and community engagement methods (Liverpool John Moores University, 2006).

Outcomes
Supported by scientific evidence, the report concluded that major effects on physical health were not expected from the incinerator itself, but from its planning application, since high levels of anxiety and stress in the local population had already been generated by the project. The application did not proceed, since the proposal was rejected by the planning commission for technical reasons. A revised proposal was re-submitted.

The HIA identified 32 different concerns mainly regarding:

- direct health effects of emissions (primarily asthma and cancer), with particular reference to children
- potential deterioration of general health condition (mainly due to cumulative and synergistic effects of other industrial developments)
- indirect effects on health and other nuisances, such as traffic and noise
- environmental and social justice issues, including, lack of information, exclusion from significant decisions and worsening of the local economy
Key points about risk perception of waste management (especially incineration)

Different forms of waste management are subject to a range of public concerns and forms of opposition, the most common being the ‘not in my back yard’ (NIMBY) syndrome (Stiglitz, 2005).

This is not a new issue, and a substantial body of literature discusses the relationship between landfills and NIMBYism (Reams & Templet, 1996; Furuseth, 1990; Lober & Green, 1994; Ishizaka & Tanaka, 2003; Marques et al, 2005; Kraft & Clary, 1991; De Feo et al, 2005; Elliot et al, 1997).

Examples of NIMBYism in relation to incinerators are also reported in the literature, although more rarely (Reams & Templet, 1996; Ishizaka & Tanaka, 2003; De Feo et al, 2005; Matsuto et al, 2003; Lima, 2004).

Petts (1992) suggests that the opposition to incineration is based primarily on public perception of:

• potential health effects of emissions
• potential accidents involving release of ‘toxic’ waste
• adverse impact on the quality of life of local people
• the management of industrial or hazardous waste
• lack of trust in operators and regulatory bodies

Public risk perception is primarily based on historical problems caused by older technologies and poor management practices, often amplified by media coverage.

Public concern about incinerators is extremely high, and the presence of a chimney stack stigmatises the entire installation (Lima, 2004; Wester-Herber, 2004).

High levels of concern arise when there is the potential for chimney emissions such as dioxins, furans, and fine particles (or fine particulate matter) (Williamson & Weyman, 2005; De Feo et al, 2005; Ishizaka & Tanaka, 2003; Roberts & Chen, 2006; Matsuto et al, 2003). People express particular concern whenever children are involved (Petts, 1992; Lober & Green, 1994; Lima, 2004; Reams & Templet, 1996).

The stigmatising effect is not confined to areas in close proximity to the site, but may involve a larger area (Satterfield, 2000; Furuseth, 1990) particularly in relation to issues such as air pollution, traffic congestion, and the potential cumulative and synergistic effects with other local industries.

It is difficult to assess the precise health impact of public risk perception per se because of the co-occurrence of other industrial activities and the high level of deprivation that often characterises areas where waste management plants exist, which act as confounding factors (Lima, 2004; Elliott et al, 1997; Brown, 1995; Reams & Templet, 1996; Midgely et al, 2005).
Case study 2: Sandon Dock – Liverpool, Merseyside

Description
Sandon Dock is a wastewater treatment plant, situated in the north of Liverpool. In April 2000, a new biological treatment stage was introduced as part of the process of water cleansing. This consisted of several filter beds containing microscopic bacteria to break down and consume organic pollutants as the wastewater passed through. The process increased the amount of odoriferous sludge produced and additional measures for odour abatement were required.

Public risk perception
Despite odour abatement measures, nearby residents very quickly started to complain. The majority of complaints arose during the summer months, from areas downwind of the plant. The objections peaked in July 2001, when 188 were received. This coincided with a rapid increase in the number of people visiting their general practitioner because of potentially related symptoms, such as nausea, vomiting and conjunctivitis (Jarvis, Richardson & Dardamissis, 2006).

Authorities’ response
Given the number and significance of complaints, the Director of Public Health for Central Liverpool decided to undertake a risk assessment. A multi-disciplinary, multi-agency health advisory group was established to investigate the case and produce a report. However, during the investigation, the operator of the plant identified a possible source of odour as a failure of the new treatment stage and new abatement measures were put in place, in November 2002. Immediately following this, the number of complaints received and the number of related general practitioner consultations dropped significantly.

Outcomes
Given the type of biological treatment, the study suggested that hydrogen sulphide and mercaptans generated by the new treatment stage were the most likely causes of the odour. Neither substance is carcinogenic and the effects noted (irritation of the respiratory tract, eyes and skin) are very unlikely to occur at the concentrations found in this situation. It was suggested that the stress the community experienced in response to the odour, caused both the high level of complaints and the recorded health effects. In this case, other nearby sources of odour in addition to the one from the water treatment plant could not be excluded (Cheshire & Merseyside Health Protection Unit, 2005).
Case study 3: Clariant works site – Cadishead, Salford

Description
In 2004, outline planning permission for the development of 288 residences on seven hectares of derelict land, the site of a former tar works, was granted by Salford City Council (Environmental Health Services - Salford City Council, 2007). Work started on the site in 2005. The bio-remediation process involved excavating the ground and treating the groundwater, previously contaminated by petroleum products, with colonies of special micro-organisms that use hydrocarbons as a food source. Such treatment commonly produces a tarmac-like odour, even if abatement measures are adopted.

Public risk perception
The local population welcomed the site redevelopment. However, from May 2006, the environmental health service began to receive complaints relating to pungent petrol-like odours. The majority came from non-adjacent residents and some even came from other nearby boroughs (Environmental Health Service - Salford City Council, 2007). The complaints continued for several months. The local press reported that some residents visited the doctor because of breathing problems, sore throats and headaches, and others left the area temporarily in order to avoid the fumes (Contaminated Land Bulletin, 2006; Keeling, 2006).

Authorities’ response
The cause of the complaints was identified as petrol-like chemicals released through the bio-remediation process. Although exposure to high levels of one of these chemicals, naphthalene, is associated with increased risk of haemolytic anaemia, damage to the liver, nervous system and eye problems, the amount in the air in this case was too low to cause these effects or be considered harmful. In addition, remediation target levels for this contaminant in the soil were set at a level far below that known to affect human health. More efficient odour control and monitoring measures were adopted on site and an information campaign carried out in the area.

Outcomes
Most of the objections quickly ceased. However, a small number of complaints was received from local residents outside the campaign area, and from a number of residents who continued to express health concerns and report effects to their general practitioners (Environmental Health Service - Salford City Council, 2007).
**Key information on risk perception relating to odour and air contamination**

People are afraid of the potential long terms health effects of gaseous emissions, and worry that they may cause respiratory diseases such as asthma and lung cancer. Odour plays an important role in the perception of the significance of any emissions, since it appears to amplify any fears (Dalton, 1999).

However, the relationship between the sensation of odour, and the annoyance and sensory irritation it causes is highly subjective and cannot be quantified. The mere presence of an unpleasant odour seems to provoke adverse sensory responses and complaints (Dalton, 2002; Dalton et al 1997; Dalton, 1996; Roht et al, 1985; Shusterman et al, 1991; Sarkar & Hobbs, 2002; Sarkar et al, 2003; Smeeets & Dalton, 2005).

Odour perception is affected by many non-sensory factors that may lower the irritation threshold and increase the reporting of health symptoms (Dalton, 2002; Dalton et al 1997; Dalton, 1996; Dalton, 1999; Shusterman, 2001; Roht et al, 1985; Shusterman et al, 1991). These factors are mainly:

- odour familiarity: unfamiliar odours are more likely to generate concerns
- type and source of odour: natural odours are less likely to cause strong anxiety. Odourless, colourless volatile chemicals are less likely to cause mucous membrane irritation and health symptoms than chemicals of a similar nature which have an odour
- interaction with other people: exchange of information about the health consequences of exposure may alter people’s adaptation to the odour
- personal ideas about disease causation: expectations about possible health outcome (e.g. fear of lung cancer) may lower their irritation threshold
- anxiety and personality orientation: people who tend to have a negative outlook on life are more likely to report health complaints

Odour generated concerns can also be affected by interpersonal factors such as age, gender, culture and previous experience (Sarkar & Hobbs, 2002; Sarkar et al, 2003; Dalton, 1999). For example, children are less affected by odour; women seem more receptive than men; and people with previous negative experiences are generally more sensitised.

Even if environmental odours are not directly related to any known hazards to human health, psychophysical well-being can be negatively influenced by exposure (Capelli et al, 2007).

On the other hand, some people may be hypersensitive to chemicals that cause odours. This can induce physical and mental distress, which can in turn affect risk perception. In extreme cases the stress may lead to muscular tension, irritability, psychasthenia\(^1\) and somatic anxiety (Österberg et al, 2002).

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\(^1\) A psychological disorder characterised by phobias, obsessions, compulsions, or excessive anxiety.
Case study 4: Malkin’s Bank golf course – Sandbach, Cheshire

Description
Malkin’s Bank golf course, in Sandbach, is located on a former industrial site that was used for disposal of waste until about 1960, when serious concerns were in part responsible for its closure. Appropriate measures were taken and the site was reclaimed in the 1970s, and then in 1982 it was finally turned into a golf course. However, high levels of benzene, toluene, sodium, ammonia, chloride, manganese and calcium were detected in the course’s drainage systems in the 1990s. The Local Authority, in conjunction with the Environmental Agency, undertook a groundwater monitoring programme at the site in 2002 (Congleton Borough Council and Cheshire County Council, 2003).

Public risk perception
Between 2002 and 2003, fears started to rise among nearby residents. Concern focused mainly on the potential increased risk of developing fatal cancers because of contamination in the vicinity of their houses. A possible cancer cluster in about 12 isolated houses and some nearby farms was claimed by the local population. However, no particular type of cancer was involved.

Authorities’ response
The Central Cheshire Primary Care Trust carried out an initial analysis of mortality data which provided no evidence of any increases in cancer deaths. However, specialist advice from the Merseyside and Cheshire Cancer Registry (MCCR) was sought (Iddenden & Williams, 2003). Statistical data on cancer incidence and mortality from all types of cancer in the potentially affected area were examined and analysed by comparison to neighbouring areas between 1981 and 2001. The expected numbers of cases for the study area were produced. The statistical analysis concluded that there was no evidence to suggest any excess of cancer cases (Iddenden & Williams, 2003). The groundwater investigation also concluded that there was no evidence of any significant risk to human health.

Outcomes
The local population was not reassured and still believes that there is a real health problem. In particular, the MCCR study was criticised because of its quantitative nature. People felt that it covered too wide an area and focused on statistics rather than on any possible cancer hazard relating specifically to the contamination (Congleton Borough Council & Cheshire County Council, 2003).
Case study 5: Housing development at Thingwall Hall – Knowsley, Merseyside

Description

Thingwall Hall, in Knowsley Metropolitan Borough Council, contains an unused terraced area with overgrown vegetation. It was formerly infilled with predominantly domestic waste, although some industrial and commercial waste was probably also deposited. In 2002, an outline application for land reclamation to be followed by residential development was granted. The prescribed remediation involved digging out the old waste and disposal of the biodegradable fraction in an engineered landfill on site, adjacent to the southern site boundary. The non-biodegradable waste was to be re-deposited back to land as part of the site’s redevelopment.

Public risk perception

Residents adjacent to the site began to raise concerns mainly relating to traffic, ecological aspects, quality of life and health. Health concerns focused in particular on the movement of old, hazardous waste and ground that was thought to be potentially contaminated with heavy metals and possibly other chemicals (Planning Committee - Knowsley Metropolitan Borough Council, n.d.; Toxcat, 1997).

Authorities’ response

The planning committee acknowledged that remediation was necessary and part of the site would not be suitable for any development for many years. The committee also felt that the issue of ‘traffic’ was not well addressed in the application and this was the grounds for the initial rejection. A Pollution Prevention and Control permit was also required for waste re-deposition. This would impose conditions on any significant potential impacts and nuisances (Planning Committee - Knowsley Metropolitan Borough Council, n.d).

Outcomes

Despite the committee’s reservations, planning permission was granted on appeal in 2007 and remediation works are expected to start as soon as possible in order to meet the statutory deadlines. Residents are still concerned about the potential for traffic problems, exposure to toxic dusts and groundwater contamination that might occur during remediation and are not convinced that the proposed remediation strategy will make the site safe for occupation.
Key information on risk perception of land contamination

In the recent past, unsafe industrial practices led to polluting substances - most commonly metals and metalloids (Dinsdale, 2007) – being deposited in, on or under the land.

Scientific literature on the perception of ‘land contamination’ is limited.

Epidemiological studies of psychosocial effects are also rare. Barnes et al (2005) reported that a few studies have demonstrated biological signs of chronic stress, including high blood pressure and high levels of urinary cortisol and noradrenaline metabolites among people affected by contaminated land.

According to Barnes et al (2002) the discovery of contaminated land in the vicinity of homes:

- may have social and psychological impacts
- can result in a depressed mood
- can induce new anxieties and intensify any existing strains
- can induce social stigmatisation
- can arouse anticipatory fears of health impacts, in particular in relation to children (Barnes et al, 2005; Moffat & Pless-Mulloli, 2003)

Predominant factors that can induce stress are: a lack of personal control over events; confusing and/or inadequate information about the pollution; uncertainty about the health effects and the possibility of their lasting over a long period (Barnes et al, 2002; Barnes et al, 2005; Elliot et al, 1993; Vandermoere, 2006).

Social effects of the stress are reflected in an increase in divorces, as well as strains on other relationships with relatives and friends (Vandermoere, 2006. See also Edelstein, 1988, cited in Elliott et al, 1993).

Living near or on contaminated land may result in a community becoming branded as ‘contaminated’, and socially stigmatised (Satterfield, 2000). People living in a stigmatised community can suffer damage to their identity and self-esteem, inducing significant secondary health effects, such as anxiety, depression, or anti-social behaviour and the adoption of unhealthy lifestyles (Wester-Herber, 2004; Satterfield, 2000).

All these elements are common in areas with high deprivation, where land contamination is most commonly found. Studies have highlighted that deprived populations are less likely to perceive environmental hazards as a problem and are therefore less likely to complain or oppose potentially hazardous new developments (Brown, 1995; Reams & Templet, 1996).
Case study 6: Local area petition - Southport, Merseyside

Description
In February 2005, a petition from residents of a residential area in Southport was presented to the Sefton Health Scrutiny and Review Committee (HSRC), regarding some new telephone masts within the area. The petition requested that the Council further review and investigate the health risks associated with living in close proximity to a telephone mast and other related equipment (Health Scrutiny and Review Working Group, 2006).

Public risk perception
The residents raised concerns over their quality of life and health, supported by several self-reported complaints of symptoms such as insomnia, dizziness, headaches, skin conditions, fatigue and poor concentration, general muscular, skeletal and mental suffering, in addition to some more specific symptoms (e.g. tachycardia, nose bleeding).

Authorities’ response
Due to the types of concerns raised, the HSRC set up a working group to review the potential risks throughout the entire borough.

This group:
1. reviewed the health concerns of residents, through direct interviews, questionnaires, emails, letters, and public meetings
2. gathered opinions from stakeholders, such as the Health Protection Agency, communication companies, independent experts
3. examined the important official and scientific literature available

Outcomes
The working group produced a report in 2006, which represented a comprehensive investigation of the issue throughout the Borough. The conclusions indicated that there were no increased health risks for residents. However, several issues were highlighted in the report, in particular:
- the high levels of residents’ concern and distrust in regulatory bodies
- the difficulties of general practitioners and the National Health Service in dealing with issues where there is a significant gap in the scientific knowledge about health effects
- the wisdom of adopting a precautionary approach with regards to vulnerable people, such as children and the elderly
Key information on risk perception of non-ionising radiation

Telecommunication masts and other similar features emitting non-ionising radiation are often accompanied by NIMBY-type objections and complaints of symptoms that affect the quality of life of the local population and present a real problem (Dolk et al, 1997; Szmigielski & Sobiczewska, 2000; National Radiological Protection Board, 2001; National Radiological Protection Board, 2004).

Public complaints generally relate to:

- possible health outcomes from continuous exposure to microwaves (cumulative effects)

- interference with everyday life (quality of life) mainly due to the visual impact of the mast or other structure

- potential loss in the value of houses (Szmigielski & Sobiczewska, 2000; Syms, 2001)

People’s perception of non-ionising radiation is predominantly affected by both personal and external factors (WHO, 2002; Slovic, 1996) such as:

- age, education, gender

- unfamiliarity with the technology

- lack of control, involuntariness and perceived unfairness of the risk due to the ‘imposition’ of a telecommunication base station

- dread of potential health effects, mainly cancer

However, this is a relatively new technology and there are still scientific uncertainties about any possible long term health effects of radiation (Szmigielski & Sobiczewska, 2000; National Radiological Protection Board, 2001; National Radiological Protection Board, 2004). Therefore, a precautionary approach is strongly recommended (IEGMP, 2000).

Precautionary measures may trigger concerns and amplify electromagnetic-field-related risk perception (Wiedeman et al, 2006). A general distrust of sources of information about radiation risks was noted in the UK (Hunt et al, 1999).

One to two percent of the total population report ‘non-specific health symptoms’ possibly attributable to electromagnetic field hypersensitivity (Levallois et al, 2002; Seitz et al, 2005). Symptoms include: fatigue/difficulties in sleeping, dizziness/nausea, headache, disturbances in concentrating and memory, nervousness, depressive mood or state, skin problems.
Case study 7: Greenall’s fire – Warrington, Cheshire

Description
On Saturday 15th of October 2005, an intense blaze took place at Greenall’s distillery and warehouse in Warrington. The fire involved different buildings, including the bottle distillery plant, where ethanol was stored, raising concerns about possible explosions. As well as this, there was concern that asbestos fibres could be released from denatured asbestos cement in the roof covering. The result of this incident was that potentially contaminated debris from the fire fell on 425 properties around the site.

Public risk perception
Initially, residents were worried about possible consequences arising from the severity of the fire and some people were frustrated by the inconvenience of being evacuated (The Warrington Guardian, 2005). The public was subsequently advised of the asbestos issue, and expressed concerns about any possible traces of asbestos deposits remaining on their homes and gardens.

Authorities’ response
The public was promptly reassured about their health and provided with advice on how to deal with any deposits from the fire, through different communication channels (letters, helpline, newspapers). Arrangements were also made by the distillery for specialist contractors to carry out a systematic cleanup of the area. Specialists, advised by the Health Protection Agency (HPA), were called to verify the extent of the contamination and to provide support to the cleanup operations. All 425 properties were offered a clean up facility (Environmental Health Service – Warrington Borough Council, 2007). The cleanup operation continued until the 19th of October 2005, when the incident was formally closed.

Outcomes
For the most part, residents were reassured by the information provided. Thirty residents asked for further information from the council. Predominant fears were about the air quality, the efficacy of cleanup operations and the possibility that traces of asbestos deposits might remain. One resident expressed a general lack of trust in the regulatory bodies referring to the absence of a proper asbestos emergency procedure. This individual continued to express concern seeking further clarification. The HPA in the North West led the development and production of a toolkit, to guide the public health response in any future large scale fire where asbestos contamination is a possibility.
Key information on risk perception of chemicals and hazardous substances

Misconception and misunderstanding of risk may be greater for chemicals than for any physical hazards (Weyman & Kelly, 1999).

Undeniably, certain substances seem to evoke “highly emotional or affective reactions” (Williamson & Weyman, 2005), such as dioxins or asbestos. Such chemicals are feared more than others, and in some cases this goes beyond any reasonable justification relating to potential harms.

The level of public knowledge about chemicals is low. Inaccuracies in understanding seem to be caused by limited access to information about hazards or to the unintelligibility of the information provided (Weyman & Kelly, 1999; Kraus et al, 2000).

The media have an important role in influencing people’s perceptions about chemicals (Weyman & Kelly, 1999). Warning messages and precautionary measures advised by regulatory bodies can serve to amplify general concerns and inappropriately heighten risk perception (Wiedemann & Schultz, 2005).

In the public’s view, chemicals are associated with unknown but likely outputs (Lee, 1986; Lee et al, 2005). The most important factor affecting risk perception has been identified as the ‘dreadfulness’ of consequences, followed by the ‘unknown’ dimension (i.e. unknown consequences, lack of control) and fear of catastrophic and long-lasting effects (Weyman & Kelly, 1999; Lee, 1986; Lee et al, 2005; Slovic et al, 2000; Kraus et al, 2000).

The way chemicals affect health is not well understood by the general public (Kraus et al, 2000). When reporting health effects, people often seem unaware of how chemical exposure might cause their symptoms (Weyman & Kelly, 1999). Professionals often use a source-pathway-receptor model to determine risk, and then refer to this when communicating with the public. This often serves to enhance confusion, since most people do not understand these models, nor how they can help determine risk.

Rather, as often reported, fear and public reaction to chemicals is significantly affected by sensorial perception (Kraus et al, 2000). Chemicals that for example have an unpleasant odour result in claims about health effects even when present at very low concentrations that would not normally be expected to cause symptoms.

Many other authors (Lee, 1986; Weyman & Kelly, 1999; Lima, 2004) remark that much of the public’s anxiety about chemical risks focuses on the cumulative effects of small quantities of chemicals with the potential of contaminating people through several routes (inhalation, ingestion etc).

On the other hand, Österberg et al (2002) report the existence of ‘multiple chemical sensitivities’ (MCS) syndrome, which is attributed to subjective intolerance of chemical smells. This is a reaction in response to very low, but odour detectable, ambient air concentrations of common chemicals.
Case study 8: Flooding in Carlisle – Cumbria

Description
In January 2005, several weeks of heavy rain followed by sudden severe weather led to flooding in much of Cumbria. The city of Carlisle was particularly affected when three rivers burst their banks in the early hours of Saturday 8 January 2005. A large area of the town centre was progressively flooded with high water levels (Calvert & Murphy, 2007). About 3,500 households and numerous businesses were affected and three people died.

Public risk perception
Residents had low expectations of the risk of flooding and were not prepared. People reported high levels of anxiety and stress or even panic.

Authorities’ response
In the early stages of the event there was a large multi-agency response. The main issue was to address the immediate risk to life (of vulnerable people, in particular) from the flood waters and from the absence of power (Astbury et al, 2005; Calvert & Murphy, 2007).

Many reception centres were activated, both on the basis of an emergency plan and also spontaneously. However, the agencies faced many difficulties due to the prolonged loss of electricity, a communication blackout and the flooding of the civic centre and the police and fire stations (Cumbria & Lancashire Health Protection Unit, 2007). However, once the immediate threat to life was over and in the weeks immediately after the flood, problems did not cease and primary care services were inundated with people experiencing severe psychological trauma caused by the loss of their homes and possessions, and dislocation from family and neighbours.

Outcomes
The local Health Protection Unit and Primary Care Trusts responded to immediate public health needs for nearly three weeks after the event. The response concentrated on practical issues such as ensuring safety, assisting in reception centres and reassuring the public (Astbury et al, 2005). The high levels of anxiety and stress in the post-flooding phase were underestimated.
Key information on risk perception of flooding

Studies on the perception of technological risks are predominant in current scientific literature, but natural hazards, such as flooding, attract less attention.

In general, natural hazards are regarded as very rare and are less feared by lay people in developed countries. Their consequences are frequently underestimated (Rasmussen, 1990; Starr, 1969; Starr & Whipple, 1980; Starr & Whipple, 1984).

However, events are often unexpected. As a consequence, impacts can be more complex and long-lasting, inducing a wide variety of anxiety and stress effects (Tapsell & Tunstall, 2007; Reacher et al, 2004; Carroll et al, 2006), such as:

- emotional effects due to the loss of and damage to possessions and property
- anxiety about security issues related to property and personal belongings
- disruption and deterioration in the quality of life
- deterioration in family and community relationships
- anxiety and fear of future flooding
- anxiety with respect to children

According to the National Institute for Health and Clinical Excellence, about 15-20% of people affected by a natural disaster will develop symptoms of post-traumatic stress disorder (Ohl & Tapsell, 2000; Tapsell & Tunstall, 2007; National Collaborating Centre for Mental Health, 2005).

In the aftermath of flooding, significant anxiety can be caused by circumstances such as having to negotiate with building contractors and insurance companies (Tapsell et al, 2002).

Personal mood, self-esteem and life-style (including health-related behaviours) can be severely affected by the disruption of the social and physical environment (Tapsell & Tunsall, 2007; Wester-Herber, 2004).

A number of studies have highlighted the relationship between flooded areas and deprivation, remarking that deprived populations are more likely to experience environmental health hazards and to be affected by their consequences (Tapsell et al, 2002; Tapsell & Tunsall, 2007; Midgely et al, 2005).

Nevertheless, it is not clear to what extent these psychological and social effects influence the perception of other illnesses, leading to an increase in visits to doctors (Carroll et al, 2006; Ohl & Tapsell, 2000; Tapsell & Tunstall, 2007; Reacher et al, 2004).
Case study 9: AML in Leftwich – Vale Royal, Cheshire

Description
Between 2004 and 2005, two toddlers died of a very rare form of leukaemia – Acute Megakaryoblastic Leukaemia – in Leftwich, Northwich. The two children lived in neighbouring homes built on an old landfill site. Because of this particularly unusual coincidence, the Royal Liverpool Children’s Hospital, Alder Hey, raised a concern about a possible link between the two cases. Both the Health Protection Agency and the Borough Council were promptly contacted (Environmental Health Service - Vale Royal Borough Council, 2007).

Public risk perception
As soon as the history of the landfill became known, concerns about ground contamination started to circulate among residents (The Northwich Guardian, 2005). People’s concerns focused on the potential risk of cancer, in particular for children. Many people expressed the suspicion that the landfill could be the principal cause of the leukaemia deaths (Environmental Health Service - Vale Royal Borough Council, 2007).

Authorities’ response
A multi-agency investigation was set up. Gas emission tests, building inspections, soil sampling and analyses were conducted, and low levels of benzene, methane and other contaminants were detected in the soil of one particular garden as well as in other parts of the estate (Vale Royal Borough Council et al, 2005). Four families were relocated during the initial investigation. The public was promptly involved in the investigation, especially through frequent public meetings (Environmental Health Service - Vale Royal Borough Council, 2007).

Outcomes
At present, an environmental cause of the cancer cannot be identified. The investigation and the soil analyses did not detect anything that could cause a significant health risk, and no other cases of cancer associated with the estate have been recorded. However, the land was designated as contaminated land in 2006, because of the high level of gases from decomposition of waste and vegetation beneath the site. Twenty four tenants in total were temporarily relocated while remediation work was carried out, including installation of gas proof membranes and ventilation beneath the houses (Environmental Health Service - Vale Royal Borough Council, 2007).
Case study 10: West Bank cancer cluster – Halton, Cheshire

Description
In December 2006, some residents of the West Bank area of Riverside, in Halton, expressed concerns, through a local councillor, about an elevated number of cancer cases among inhabitants of two adjacent streets. Halton is home to one of the UK’s largest chemical manufacturing complexes. This chemical industry development has left the Borough with problems of air and land pollution (Halton Borough Council, 2005). Elevated concentrations of metals, sulphate and aromatic hydrocarbons have been detected in some areas near the two affected streets and the Environmental Health Department of Halton Council did not exclude the possibility of some contamination of the area from previous, as well as current, industrial land uses.

Public risk perception
Concerns expressed by the residents regarded generic types of cancer (such as ‘blood cancer’ or cancer ‘of the nose’). Also, potential causes were attributed to common forms of environmental contamination such as land contamination (Cleary & Stewart, 2007). This was supported by public perception of ‘poor environmental condition’ in the Borough (Research and Policy Units, 2003).

Authorities’ response
The Cheshire & Merseyside Health Protection Unit undertook an initial investigation on behalf of the Primary Care Trust in order to exclude the possibility of a cancer cluster. The information reported by the residents was compared with data on hospitalisation and mortality for a wide variety of cancers between 1981 and 2004, available from the North West Public Health Observatory (Cleary & Stewart, 2007).

Outcomes
Analysis of the available statistical data did not reveal an excess of cancers of any particular type and the report concluded that any further analysis did not appear to be warranted. However, the report acknowledged that Halton experiences very high levels of deprivation and mortality rates are higher than average and suggested that further and better communication with the public was clearly required (Cleary & Stewart, 2007).
Key information on risk perception of cancer due to environmental factors

Very little is reported on public perception of each type of cancer, and almost nothing on the general fear of cancer, even though the numerous requests for generic cancer cluster investigations suggest that public concern is high (Trumbo et al, 2007; Trumbo, 2000).

Suspected cancer clusters are usually highlighted by resident action groups and/or the media, but they frequently relate to different tumour types, far apart in time and space (different geographical locations) without a rational link.

The claims are more often non-specific, and can be associated with a NIMBY syndrome. However, some claims do refer specifically to breast cancer, leukaemia, lung cancer and brain tumours (Trumbo, 2000).

When the investigation is undertaken, a unique form of cancer related anxiety can often be found in a community that has been alerted to a particular threat (Trumbo et al, 2007).

This anxiety seems to be supported by public beliefs (Trumbo, 2000; Trumbo et al, 2007), such as:

- cancer is one single disease
- it is unavoidable
- it is a very terrible way to die
- it is still a mystery, has unclear causes, but may be somehow related to some ‘chemical pollution’ or other environmental factors (Trumbo, 2000; Trumbo et al, 2007)

In particular, public concern is often associated with the technological nature of some hazards that may cause cancer, such as radiation and chemical agents (Gregory et al, 1996).

According to Lee et al (2005), this association reflects a very strong relationship between environmental and social health perception and cancer dread.

The uncertainty of any possible health hazard outcomes increases this dread (Slovic et al, 2000).

As a consequence, people’s concerns often focus on unusual sensorial signals, such as an unfamiliar smell in the air or a visible smoke plume whose origin is unclear (Trumbo, 2007).

However, some important factors such as life-style and deprivation may affect cancer occurrence thereby making any investigation of environmental causes very difficult. These factors, also, may significantly affect risk perception and determine public discontent and distrust in regulatory bodies (Midgley et al, 2005; Brown, 1995).
Conclusions and recommendations

Conclusions
The cases analysed and the scientific literature mentioned in this report are not exhaustive and much more work is needed to fill the gap between theory and practice in environmental health risk perception. However, some important lessons have been learned.

Risk perception is an important aspect of the interaction between environment and health. It is often difficult to determine whether symptoms are directly related to an environmental hazard (such as land contamination) or to the cognition of its risk. It is difficult to understand how an individual’s psychosocial background affects symptoms.

Only recently, studies have begun to investigate the effects that concerns about environmental hazards and stressors have on human health. The less acceptable the hazard, the more likely it will induce health impacts.

Some potentially hazardous technologies are investigated in more depth than others, often because of social and media amplification of risk. On the other hand, less attention is devoted to natural disasters, even when they become more likely, such as flooding and hurricanes.

People seem to react particularly strongly to land contamination and air pollution. Frequent concerns also focus on specific sources of pollution (such as landfill or incinerators) and on potential outcomes (mainly cancer) regardless of any plausible cause-effect relationship.

However, the public appears to have limited understanding of contamination mechanisms and most people do not understand concepts such as ‘dose-response’, or ‘source-pathway-receptor’ models. Perceived risk and related somatic symptoms do not correlate well with observed contaminant concentrations.

Some of the difficulties in communicating risk to the public may occur because the complex concepts relating to the source-pathway-receptor model that is usually adopted by professionals to analyse risk are not well understood.

It is therefore not unsurprising to find that the reported results of many hazard investigations are considered unsatisfactory by the public and do not meet their expectations.

Recommendations
In general, more public debate is needed on environmental health issues that affect the public. More public representation is needed when new policies and plans, such as a local waste strategy are under development.

Planners and decision makers need to seek advice from appropriate professionals about environmental hazards when they receive complaints from the public.

Regulatory bodies and health practitioners should acknowledge and address public perception of risk and its manifest link with health and wellbeing when exploring and communicating the health impacts of environmental hazards.
Risk communication should be improved. In particular, the reliance on technical/statistical information alone should be avoided since this may create more confusion. Technical reports rarely address public concerns and more research to understand risk perception is needed so that an effective risk communication strategy can be implemented.

Consideration of perceived risks should be part of local environmental investigations, particularly in relation to:

1. cancer related anxiety and its relationship with cancer cluster investigations
2. ‘special’ chemical substances that evoke highly emotional public reactions such as dioxins
3. anxiety, stress-related effects and other psychological impacts that occur in the aftermath of flooding
4. assessment of new waste management technologies such as mechanical and biological treatment (MBT) or refuse derived fuel (RDF) plants
5. assessment of any significant nuisances generated by soil remediation
6. the public risk perception in relation to air monitoring and pollution mitigation measures, such as Air Quality Management Area

Further areas of concern, not covered in this report, but worthy of investigation include:

1. food safety
2. water contamination
3. other natural hazards (e.g. heat waves and cold spells)
4. power generation, including new technologies, such as wind turbines, tidal or wave power generation
5. transportation systems (people’s travel perception and behaviour and its impacts on health)
6. other commonly ‘underestimated’ risks, such as radon and carbon monoxide

Demonstrating relationships between environmental risk perception and health is extremely difficult and beyond the remit of this report. However, risk perception as a cause of ill health has certainly been underestimated in the past and continued funding for research to explore and address these issues will benefit the public’s health.
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