

Water shortages and extreme events: a call for research

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ABSTRACT

Water shortages as a result of extreme weather events, such as flooding and severe cold, have the potential to affect significant numbers of people. Therefore, the need to build robust, coordinated plans based on scientific evidence is crucial. The literature review outlined in this short communication was conducted as part of a joint Drinking Water Inspectorate and Health Protection Agency (now Public Health England) report which aimed to review the scientific evidence base on extreme events, water shortages and the resulting health impacts. A systematic literature review was undertaken to identify published literature from both peer-reviewed and grey literature sources. The retrieved literature was then assessed using the Scottish Intercollegiate Guidelines Network quality assessment. The authors found very few scientific studies. However, a great deal of valuable grey literature was retrieved and used by the research team. In total, six main themes of importance that were identified by the review and discussed included health impacts, water quantity and quality, alternative supplies, vulnerable groups, communication with those affected and the emergency response. The authors conclude that more research needs to be conducted on health impacts and extreme events water shortages in order to build the future knowledge base and development of resilience.

Key words | extreme weather, public health, water shortages

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INTRODUCTION

Extreme weather events such as flooding and severe cold have resulted in the significant loss of mains water supplies in a number of European countries over recent years. For instance, in 2007, the UK experienced the largest loss of combined electricity, water and sewage services since World War II as a result of extensive flooding (Pitt 2008). Almost 500,000 people were left without mains water or electricity following the direct flooding of water treatment works and/or electricity substations. The Pitt Review, published in 2008, reviewed the emergency response and recovery and made recommendations for future practice (Pitt 2008).

In July 2011, the Drinking Water Inspectorate (DWI) commissioned the Health Protection Agency (HPA) to undertake a literature review of the scientific evidence base on extreme events, water shortages and health impacts, and produce a document entitled 'Health Impacts of

Extreme Events Water Shortages' (Carmichael *et al.* 2012). The aim was to utilise the retrieved evidence to generate a set of key points for consideration that could be used by both the health and water sectors in their preparation, response to and recovery from water shortages related to extreme weather events. This short communication details the process and outcomes of this document. It also highlights the needs for further research; one of the crucial findings of the literature review was that there was an absence of robust, high quality research in the field of water shortages and extreme events.

A systematic literature review was undertaken to identify published literature from both peer-reviewed and grey literature sources. Databases searched included Medline, Global Health, Embase and the Cochrane Collaboration with limits set to 'English', '2005–current' and 'human'

and used key words related to extreme events and water shortages. Pre-agreed exclusion and inclusion criteria were applied to all findings. Once the literature search was complete the research team assessed the quality of the evidence using the Scottish Intercollegiate Guidelines Network (SIGN) quality assessment which uses a grading system from 1 (highest quality evidence) to 4 (evidence of lowest quality) (SIGN 2011).

In total, 24 papers were retained from the search which identified a notable absence of robust scientific studies on the public health impacts of water shortages during and following extreme events. More appropriate literature was assigned a SIGN grading of 3 or below (non-analytic studies, e.g. case reports, case series) with almost 30% of all literature graded a 4 (expert opinion). No papers were graded 1 or above (high quality meta-analyses, systematic reviews of randomised control trials (RCTs), or RCTs with a very low risk of bias). The published report (Carmichael *et al.* 2012) therefore relies heavily on grey literature which includes reflective reports, policy documents, case studies and guidelines from various agencies highlighting the lessons identified from previous events.

A number of case studies generated from the published literature revealed instances where extreme events have led to significant interruptions in mains supply and initiated an emergency response. Six main themes of importance were identified and included health impacts, water quantity and quality, alternative supplies, vulnerable groups, communication with those affected and the emergency response.

Health impacts

Water shortages have been documented to cause panic, despair, feelings of exposure, distress and helplessness among affected populations (Pitt 2008; Water UK 2008). Paranjothy *et al.* (2011) in their survey found that 'loss of essential services' such as water worsened mental health 'two- to three-fold'. This may have been exacerbated in the elderly, people with disabilities, parents with small children, those without money or cars who could not get to alternative supplies.

Water quantity and quality

The UN Economic and Social Council highlights the legal base of the right to water, stating that 'The human right to

water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses. An adequate amount of safe water is necessary to prevent death from dehydration, to reduce the risk of water-related disease and to provide for consumption, cooking, personal and domestic hygienic requirements' (UN Economic and Social Council 2003, p. 2).

The Sphere project (internationally recognised guidelines into the minimum standards in disaster response) provides key actions, standards, indicators and guidance notes for emergency humanitarian response (Sphere 2011). They suggest a quantity of between 15 and 20 litres/person/day (hospitals = 40–60 litres/inpatient/day with more for other services such as laundry) to inform the immediate emergency phase with adequate provisions of supplies (Sphere 2011). They also recommend that people do not have to wait longer than 30 minutes for collection (Sphere 2011). However, it was unclear where the evidence base for these quantities and times was developed from.

Under the Security and Emergency Measures Direction (SEMD), water companies within the UK are required to provide by alternative means a minimum of 10 litres per day in the event of a supply failure (OFWAT 2007). However, consumers used to an average daily consumption of around 138 litres/person/day would obviously find adapting to this emergency volume very difficult as they must change their usage of water drastically (OFWAT 2007). It is also important to note that quantities utilised may differ between cultures, individual practices, traditions, habits, religion, coping mechanisms and personal experience (Sphere 2011).

Vulnerable groups

Vulnerable groups can be described as those who are likely to have additional needs and experience poorer outcomes if these needs are not met (Nottingham Gov 2008). Identification of possible vulnerable groups at risk from water shortage is advised during emergency planning with the active involvement of communities (WHO/HPA 2011). As the Pitt review highlights, when essential services such as water are cut off, everyone feels vulnerable and people who are not traditionally classed as vulnerable may become so due to a lack of access to alternative supplies (Pitt 2008). Following the Mythe incident, the rethinking of

'vulnerable' to include (among others) babies, chronically sick, the elderly and those not strong enough to carry water or able to get to water was highlighted in reports (Water UK 2008).

Alternative supplies

Alternative supplies can be delivered to affected communities via a number of routes, including tankers (static or bowser) and/or bottles (Water UK 2008). However, these supplies need to be carefully dispatched and monitored in order to protect public health. During the Gloucestershire floods (2007), vandalism of tankers (letting tap run, theft, urinating or introducing chlorine into tank) endangered public health and reduced the available stock from 1,950 to 1,500 (Consumer Council for Water 2007).

People are advised to boil water from tankers, as the containers people use to transport the water home may not have been cleaned hygienically thus increasing the risk of contamination. Such advice should be clearly displayed on the outside of tankers prior to distribution of alternative supplies (DWI/HPA 2009). This water, once boiled and cooled (for no longer than 30 minutes), is suitable for making up infant formula feed (HPA 2008).

Communication

A pre-defined communication plan was highlighted as an essential component of an emergency plan (Consumer Council for Water 2007). Transparent, honest, accurate, consistent and direct communication is vital between responders (both in the water and health sector) and with the public through their direct involvement (Menne 2005). Ongoing communication utilising all available channels should underpin the response activities from water companies and health authorities (DWI/HPA 2009). Consequences of the event, such as disrupted communication channels, increased website and call centre needs and potential lack of electricity, must be taken into account (Water UK 2008).

Emergency response

The literature showed that because the public are often not aware of emergency plans, there was a perceived lack of

coordinated responses to water shortages (Consumer Council for Water 2007). To ensure public trust and confidence, the literature advises that emergency plans be made available to the public (Consumer Council for Water 2007). Coordination of the emergency response has been shown to be particularly challenging when more than one extreme weather event occurs simultaneously, such as flooding and snow (Tapsell & Tunstall 2008).

DISCUSSION AND POINTS FOR CONSIDERATION

Very few peer-reviewed articles were found that addressed the health impacts of water shortages during flooding or describe organisational responses. This has previously been noted by Ahern *et al.* (2005) who highlighted the need for research into the public health consequences of flooding and evaluations of interventions intended to reduce health risks. They suggest the current lack of studies is a possible result of the unpredictable and sudden nature of flooding alongside the lack of baseline data available on sample populations (Ahern *et al.* 2005). Due to the nature of disasters, their inherent unpredictability and the immediacy required of the response, it is often not possible to undertake rigorously pre-planned RCTs. However, a number of valuable published reports and reflective reviews were retrieved from the search of grey literature.

Health effects of water shortage after flooding were not well documented in the published literature. However, the search did reveal that gastrointestinal upset following flooding has occurred sporadically, thus indicating the importance of a supply of water for basic care and personal hygiene. Mental health symptoms have also been documented as a direct result of water shortages and should therefore be considered among both water and health professionals during the planning, response and recovery stages of water shortages. In view of the lack of published literature, the authors suggest exploring the need for an agreement between health groups to undertake enhanced surveillance, formally documenting and publishing where possible. This would include the health of the affected population during and after an extreme weather event. Development of 'how to' protocols and guidance relating to enhanced surveillance, health and water shortages would also be beneficial.

This would aid in the development of an empirical database which underpins policies and practice.

A quantity of around 10–15 litres/person/day is advised in the literature, but the evidence behind this was not made explicit and the specific quantities, dependent on vulnerabilities, were not apparent in the available literature. Research into the quantity of water required by certain vulnerable groups and the provision of advice for limiting water use is therefore recommended. In terms of both communication and the emergency response, it is apparent that a clearly communicated plan that is fully accessible to the public is beneficial during the response and having clear communication about preparation of tanker water and bottled feed is essential. Having a ready-to-disseminate set of communication tools in a range of languages would also aid in the transmission of advice given the evidence on specific groups and tailoring of need. Finally, considering inclusion of multi-event scenarios (e.g., freeze–thaw *and* flood) in emergency exercises would aid coordination of particularly challenging events.

The health impacts may well change over time during large events. Also, loss of water supply alongside power shortages may create sanitation problems which would in turn add extra complexities to any response. However, these impacts can be predicted in advance and therefore planned for in relation to alternative supply provision, communication with consumers and health surveillance.

Due to the lack of epidemiological studies found, the published document relied heavily on grey literature which is not peer reviewed and is based on the opinion and experiences of individual organisations. However, local guidance, previous experiences and institutional reports are an extremely important tool and despite their inherent weaknesses within evidence-based public health, they are seen as an essential component of the final report.

CONCLUSION

Extreme events water shortages have the potential to affect significant numbers of people and so the need to build robust, coordinated plans which are based on scientific evidence is vital. The literature review conducted as

part of this joint DWI/HPA report found very few scientific studies in this field and the SIGN guidance categorised most articles as a grade 3 or 4. Nevertheless, the value of the grey literature in the identification of lessons gained through experience is recognised by the research team. In conclusion, expanding the scientific literature and encouraging the conduction of research in this field is essential for the future knowledge base and development of resilience.

ACKNOWLEDGEMENTS

We would like to thank all those who took the time to attend our workshop and give us their feedback, comments and advice on the initial drafts of the larger document.

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First received 4 September 2012; accepted in revised form 26 March 2013. Available online 24 April 2013