Reducing Environmental Impacts of Vector Control Chemicals in Emergencies[1]

Revised from the original, developed for
ProAct Network and CARE International for the Global WASH Cluster

Introduction

Disasters, and their aftermath of destroyed infrastructure, debris, displaced populations and damaged sanitary services, create environments in which vectors can increase dramatically. These vectors pose some of the most significant health challenges following disasters. Insects such as mosquitoes, flies and fleas and rodents such as rats and mice can transmit a wide range of diseases which can increase the suffering of disaster survivors and lead to unnecessary mortality in the worse cases. The table below summarizes some of these vector-disease linkages.

Post disaster sanitary and hygiene efforts need to create an environment where vector breeding and nesting sites and the opportunity for vectors and human contact are removed or reduced to a level which makes the disease threat of vectors inconsequential. This short note on **Reducing Environmental Impacts of Vector Control Chemicals in Emergencies** provides guidance to personnel in the field on how to effectively limit the impact of vectors, as well as the environmental impact of chemical control measures which are often used in vector control.

The information contained in this note will aid in planning vector control efforts. However, further review of the documents listed in the **Further Information on the Web** at the end of this note is recommended before launching a full scale vector control effort.

Vectors and Associated Diseases

Vector	Associated Diseases
Mosquitoes	Malaria, Yellow Fever, Dengue, Viral Encephalitis, Filariasis
Houseflies	Diarrhea, Dysentery, Conjunctivitis, Typhoid Fever, Trachoma
Cockroaches	Diarrhea, Dysentery, Salmonellosis, Cholera
Lice	Endemic Typhus, Pediculosis (head, "crab" or body lice), Relapsing Fever, Trench Fever
Bedbugs	Severe skin inflammation
Triatomid ("Kissing", "Conenose", "Assassin") bugs	Chagas' Disease (American trypanosomiasis)
Ticks	Rickettsial Fever (e.g., African tick-bite fever), Tularaemia, Relapsing Fever, Viral Encephalitis, Borreliosis (e.g., Lyme Disease)
Rodent (mites)	Rickettsial Pox, Scrub Typhus
Rodent (fleas)	Bubonic Plague, Endemic Typhus
Rodents	Rat Bite Fever, Leptospirosis, Salmonellosis, Melioidosis (Whitmore's Disease)

Source: Adapted from Box 10.1 Vectors and diseases likely to be present in emergency settlements, page 129, **Environmental Health in Emergencies and Disasters: A Practical Guide**.

Key Concepts

The core concept to reducing the health threat posed by vectors is *environmental modification*, that is creating environments where the vectors cannot exist, or where their presences so minor to not pose any threat to health. Environmental modification includes a range of actions associated with effective sanitation and hygiene, as described below.

The use of chemicals to control vectors is one form of environmental modification, but is the least preferred for four reasons:

[1] Contact: C. Kelly, havedisastercallkelly@gmail.com.

1. Pest control chemicals, the equipment necessary for their safe use and disposal and the logistics required for proper control efforts, are costly. If there are other ways to achieve the same goal at lower cost, they should be used.
2. The organization of chemical control operations is complex and requires trained personnel and oversight. Other forms of environmental modification are less complex and easier to implement.
3. Pest control chemicals are generally non-specific, that is they will often impact beneficial insects as well as the vectors targeted for control.
4. Pest control chemicals are deadly. Mistakes in the use, storage and disposal of pest control chemicals can lead to human and animal poisoning and death.

These points are raised not to argue that pest control chemicals should not be used, but that they should, in general, be used as a last resort, and based on clear analysis that the cost associated with chemical control are off-set by the expected benefits to human health.

There are, of course, exceptions. The most common exception is the use of insecticide-treated bed nets. These nets limit physical contact with mosquitoes (creating a barrier, a form of environmental modification) and reduce the overall number of mosquitoes posting a health risk through a contact pesticide.

The second core concept is the use of barriers to keep vectors from locations where they can pose a health risk. Screens windows and mosquito nets are two common barrier methods to limit contract between vectors and humans. Traps can be used as another form of barrier, as is the simple blocking of access points into structures where vector breeding takes place (e.g., latrines) or where vectors come in contract with humans (kitchens).

Vector Control and the Sphere Standards for Humanitarian Assistance

The **Sphere Standards for Humanitarian Assistance** (**Sphere**) provide two standards and a range of key actions, indicators and guidance notes on vector control. Key elements of these standards are:

- Vector Control Standard 1 provides that *people live in an environment where vector breeding and feeding sites are targeted to reduce the risk of vector-related problems* and covers the use of biological, environmental and chemical control options.
- Vector Control Standard 2 provides that *all affected people have the knowledge and means to protect themselves and their families from vectors that can cause significant risk to health or well-being.*

The full **Sphere** text on vector control should be consulted in planning and implementing any vector control program.

Surveillance

A key element in a successful vector control program is the surveillance of possible vectors to detect possible threats and assess the effectiveness of control measures. Surveillance can range from the simple (are there any flies present) to the complex (understanding the level of possible resistance of a vector to a specific pesticide formulation).

In general, the early stages of most emergency operations do not provide time for more than simple surveillance methods. These methods consist of:

- Monitoring the visible presence of vectors – can flies, cockroaches, mosquitoes, rats or other vectors be seen? Note that some vectors may be more present at night and that

disaster-affected populations are likely to be very aware of the presence of the most common vectors.

- Searching for vectors in locations where they may breed or reside – these sites are most often in areas not common to human traffic, such as under debris piles, between walls, in sewage systems and in areas of standing or flowing water.
- Searching for specific evidence of specific vectors – for instance, looking for rate faeces in food handling areas, lice in clothing or bed bugs in bedding.

These three surveillance methods can be formalized into standardized reporting forms using a check list approach (e.g., is there evidence of a vector being present or not) with specific staff assigned to regularly (daily, in most cases) conduct surveillance visits throughout a camp or other shelter location. These results can be tabulated daily by the location the information is collected, to quickly assess changes in the presences of vectors. The same process, undertaken on a regular basis, can be used to compare vector presence before after control operations, to provide a means to quickly assess the effectiveness of these operations.

Note that this surveillance approach does not indicate whether any vector actually carries any of the diseases summarized in the **Vectors and Associated Diseases** table above. The presumption is that if a vector is present in any significant number then there is a health risk which should be addressed.

The longer a shelter site (e.g., camp, communal housing) remains in existence, the more sophisticated surveillance methods can become. The next step-up from the simple system described above is the collection of specific vector samples and testing them for the presence of specific diseases. This sampling and testing process requires a formal sample collecting regime as well as facilities and technicians capable to performing the testing necessary. The need for this level of effort should be assessed at the beginning of an emergency operation and implemented with the assistance of specialized pest control experts.

Environmental Modification

The objective of environmental modification for vector control is to eliminate contact between vectors and vulnerable populations.[2] The basic approaches to vector control through environmental modification are:

1. Remove or reduce the locations where vectors breed to reduce the number of vectors threatening humans, and,
2. Create appropriate barriers for the remaining vectors to further eliminate contact with humans.

The means to reduce breeding and create barriers vary by vector and physical settings. The table below identifies the most common means of environmental modification for the most common vectors. For vectors not covered, the modification mechanisms are likely the same as for similar vectors mentioned below.

[2] Eradicating vectors is both impractical and could result in significant damage to the environment by disrupting food chains and ecological balance.

Vectors and Environmental Management		
Vector		**Management Methods**
Mosquitoes	Anopheles	• Avoid source areas (1 to 2 km upwind from vector breeding sites such as lakes and marshes). • Drain temporary water bodies if possible. • Screen window and doors. • Use mosquito nets, treated or untreated.
	Aedes	• Avoid source areas (1 to 2 km upwind from vector breeding sites). • Drain and remove all water holding containers – cans, tires, pots, etc. • Screen window and doors. • Use mosquito nets, treated or untreated.
	Culex quinquefasciatus	• Seal latrines, septic systems and drain fields. • Place screens over vent pipes from latrines and septic systems and drain fields. • Screen window and doors. • Use mosquito nets, treated or untreated.
Flies		• Screen windows and doors. • Remove food from areas where flies cannot be excluded. • Collect excreta and organic waste including rotting fruit to remove breeding sites. • Frequently collect garbage. • Frequently clean waste receptacles and waste collection areas. • Use traps, including sticky paper (indoors) and cone/bated traps (outdoors) • Electrical ultraviolet light traps (indoor use) • Fly swatter
Cockroaches		• Remove sources of food. • Daily removal of garbage and food waste. • Regular cleaning of food preparation and food storage areas (using steam is possible). • Seal crevasses and access to inter-wall spaces (e.g., around pipes, wiring and shelves). • Seal around latrines and septic systems and sump tanks used to hold gray water (e.g., from washing areas). • Install screens or traps to prevent access to drainage pipes. • Eliminate moist areas and increase air flow to dark areas (e.g., behind walls, attic).
Lice		• Wash clothing and bedding in water over 60 degrees centigrade and dry in hot air. • Dry clean clothing, bedding and other similar items. • Place items in plastic back and keep at -15 degrees centigrade for 10 hours. • Use appropriate shampoo and combing to control individual infestations. (Note that lice may also be treated as a health care issue and some shampoos used contain pesticides.)
Bedbugs		• Repeated vacuuming of infested mattresses, furniture and carpets.

	• Steam cleaning of infested items and locations. • Sealing cracks and spaces where bud bugs may hide. • Heating rooms to 60 degrees centigrade for two hours or chilling to freezing and below for several days. • Placing items in a dryer
Triatomid ("Kissing") bug, Conenose bug, Assassin bug)	• Remove hosting areas and sealing access to buildings. • Screen windows and other entries. • Move lights away from windows and doors at night. • Remove rodent nets from near shelter locations. • Remove wood piles and debris. • Place double-sided sticky tape to bed legs. • Use a mosquito net tucked into the bed to prevent access to sleeping individuals.
Ticks	• Limit contact with animals and vegetation which may harbor ticks. • Frequent inspections of clothing and body to remove ticks when present. • Clear vegetation from near habituated areas to limit contact with ticks.
Rats	• Collect and dispose of all waste on a frequent basis. • Store waste in rat-proof containers. • Store food in rat-proof containers • Plug holes and gaps which allow access to buildings • Ensure screens over vents and windows are do not have holes. • Ensure utility access points to buildings (e.g., for water pipes) are sealed. • Clear debris and waste from around shelter site to eliminate breeding sites near the site.
Mice	• Plug holes and gaps which allow access to buildings, including gaps as small as 1 cm. Collect and dispose of all waste on a frequent basis • Store waste in mice-proof containers • Store food in mine-proof containers. • Conduct frequent cleaning of food handling areas/kitchens to reduce food residues • Ensure food storage areas do not allow mouse access. • Plug holes and gaps which allow access to buildings • Ensure screens over vents and windows are do not have holes. • Ensure utility access points to buildings (e.g., for water pipes) are sealed. • Use traps or glue boards as barriers to mouse movement into food handling or habitation areas.
Sources: * **Integrated Pest Management (IPM) in and Around Buildings** * **UC IOM Online, Statewide Integrated Pest Management Program,** * **Emergency Control of Vectors Using Chemicals.**	

As is clear from the preceding table, most means of environmental modification relate directly to proper sanitation and hygiene practices, basically maintaining a clean environment. At the same time, the context of environmental modification is different when disaster-affected populations

are located in organized camps, ad hoc camps, other communal settings and when they are located near or at their normal residence, as discussed below.

Organized camps[3] often have very simple, purpose build, infrastructure which allows for the introduction of vector management approaches (e.g., "VIP" latrines) from the start of the creation of the camp. As most camp residents are asset-poor when the first come to a camp, there is minimal waste generation. The basic infrastructure, and often dense, grid layout of camps, allows for quick waste collection. The frequent underemployment in camps provides a source of labor for clean-up and broader vector control efforts. As a result of conditions in camps, most vector control efforts focus on:

1. Building vector resistant infrastructure (i.e., for sanitary, cooking, and living purposes) as a camp is established
2. Frequent and extensive clean-up and maintenance campaigns to ensure a clean environment (including keeping toilets, drainage and garbage collection areas clean) as well as the washing of food preparation areas.
3. Providing residents with the means to create barriers against vectors, for instance mosquito nets or rat-resistant food containers.

Ad hoc camps present almost the opposite to organized camps from a vector management perspective. The ad hoc and often poor infrastructure and poor organization of these camps often leads to conditions which promote vector breeding and human contact. While abandoning ad hoc camps is the ideal way to deal with their vector challenges, in practical terms the following actions can be used to significantly reduce the threat from vectors:

1. Progressively upgrading sanitary infrastructure (latrines, washing areas, drainage, garbage areas) to reduced vector breeding and feeding sites, with all new infrastructure designed to resist vectors. (Most ad hoc camps are in a continual process of upgrading facilities.)
2. Frequent and extensive clean-up and maintenance campaigns to ensure a clean environment using the unemployed/underemployed often found in ad hoc camps.
3. Upgrading cooking areas to reduce the vector feeding opportunities and provide for sufficient water and soap for cleaning utensils and food preparation areas.
4. Providing residents with the means to create barriers against vectors, for instance mosquito nets or mouse/rat-resistant food containers.

Communal sites (e.g., schools, meeting halls, abandoned factories used for temporary shelter) present a number of vector management challenges. The most significant immediate challenge is that these buildings are usually not built or maintained to prevent vector access or breeding.

In addition, communal sites often lack sufficient sanitary and cooking facilities may face the overcrowding of residents in open spaces (e.g., classrooms or social halls). These conditions make effective sanitation and hygiene a significant challenge. Actions to address the vector management challenges in communal sites include:

1. Repairing building and facilities to create barriers to the movement of vectors to the areas of human occupation and use (e.g., sleeping and cooking areas), for instance, plugging holes in walls, replacing damaged windows or adding screens to kitchen areas.
2. Sanitation and hygiene (clean-up) campaigns within the site as well as in the areas surrounding the communal site, where vectors may be breeding.
3. Upgrading sanitary and cooking facilities to limit vector breeding and feeding areas

[3] The word "camp" is used here to refer to sites where disaster survivors are living away from their normal place of residence and not in an existing building.

4. Providing residents with the means to create barriers against vectors, for instance mosquito nets or mouse/rat-resistant food containers.
5. Ensuring sufficient resources (soap, water) and facilities for washing clothing, bedding and cooking utensils and facilities.

Near or at normal residence, where disaster survivors do not want to move far from their pre-disaster residence, in many cases, preferring to live in or directly adjacent to a damaged home or business. The most significant immediate vector management challenge is that created by the debris and waste created by the disaster, followed by the often ad hoc nature of sleeping and cooking conditions established by each affected family. The following actions can be used to improve vector management in or near normal residences:

1. Removing debris and waste created by the disaster as quickly as possible. (See https://www.unocha.org/sites/unocha/files/DWMG.pdf for guidance on debris management.)
2. Upgrade sanitation and cooking facilities in existing residences to limit vector breed and feeding, if possible, or establishing new, vector resistant, sanitation and cooking facilities for the affected family.
3. Ensuring frequent garbage collection.
4. Ensuring sufficient resources (soap, water) and facilities for washing clothing, bedding and cooking utensils and facilities.
5. Providing residents with the means to create barriers against vectors, for instance mosquito nets or rat-resistant food containers.

Surrounding environment, often a natural source of vectors or breeding sites which may impact where disaster survivors are residing. While standards call for not siting post disaster shelter near vector breeding sites, practical considerations may not make this possible. Of specific concern are areas of standing water, garbage and debris dumping sites, food processing facilities and abandoned buildings which may provide vector breeding locations.

As feasible, the environmental management approaches summarized above should be expanded to include potential vector source areas in the surrounding environment, particularly through clean-up and removal of breeding sites. Where these measures are not possible or not expected to be fully successful, additional site specific control measures should be implemented at the shelter site.

Chemical Control[4]

As noted above, chemical control presents a number of challenges which need to be managed properly for control efforts to be successful. Success is defined in terms of (1) the safe use of hazardous materials and (2) the use of the smallest quantity of chemicals necessary to limit the vector threat, as well as the total body-count of vectors killed.

A considerable literature has developed over the years on chemical control of vectors, with key documents readily accessible on the web (see **Further Information on the Web**, below.) In using this literature two points need to be kept in mind:

1. The chemicals and biological agents used to control vectors are evolving from substances which have a broad effect on the environment to ones which have limited and sometimes very targeted impacts on specific species, or stages of species

[4] While not strictly chemicals, the use of biological control agents is included in this section.

development. The most up-to-date chemicals or biological agents should be used even if older supplies are available at low or no cost.
2. Application methods and tools are also evolving. Even relatively recent documents may not include the most advanced tools and methods being used.

In addition to the sources mentioned below, advice on pesticide use can be available from Ministries of Agriculture (e.g., integrated pest management programs) and Health (e.g., malaria control programs). These organizations may also be able to provide training in the management of pesticide operations.

Safety is paramount in chemical control operations. Pesticides by nature are toxic and often deadly to humans in relatively small quantities. A Safety Plan should be developed for each chemical control operation and include the following elements:

1. A technical description of the substance to be used, including
    a. The formulation to be used,
    b. Likely routes of human intoxication (e.g., dermal, oral),
    c. Information on symptoms of intoxication and treatment,
    d. Conditions under which and locations where the pesticide should not be used, and
    e. Protection measures for applicators and during application.

   This information should be shared with medical personnel who would likely receive a pesticide poisoning victims. Much of this information is available from a pesticide supplier or manufacturer.
2. Information on the safe handling and application of the pesticide being used, including applicator protection measures. Commonly available from the pesticide manufacturer/supplier and the application equipment supplier/manufacturer.
3. Guidance to populations where the pesticide will be used on limiting contact and avoiding contamination (e.g., covering water and food supplies). This guidance should be formulated into a public information campaign to be launched before any pesticide is applied.
4. Written procedures for the safe transport, formulation and application of the pesticides, detailing action to be taken in the case of accidents, spills or apparent intoxication. This information is available from standard texts on pesticide application operations and training.
5. A justification for the selection of specific pesticides for the treatment of specific vector problems.
6. The results of any environmental review of the use of the pesticide. Some funding agencies may require, or have already developed environmental reviews for the use of specific pesticides. These reviews may set out specific procedures to be followed if the agency's funds are to be used to support use of a pesticide. Such reviews can also contain information needed to address other requirements on this list.
7. A plan for the disposal of all empty pesticide containers and the cleaning and decontamination of treatment equipment and applicators.

The safety plan should be publicly available and used in the training of applicators and other personnel involved in pesticide use operations.

Assessment

Any use of pesticides should be based on an assessment of the

1. The presence of vectors in numbers which pose a human health risk,

2. Potential human consequences of a vector-linked health event (e.g., a significant upsurge in malaria),
3. Effectiveness of non-chemical control measures (alternatives to pesticide use should always be considered in the planning of any control operation),
4. Environmental and economic costs involved and
5. Public willingness to allow the use of pesticides.

The decision to use chemicals control measures should be based on a joint decision of health and pesticide control experts. The surveillance information described above is also critical, as it is likely that chemical control operations will be needed when the number of a specific vector exceeds other environment management control efforts.

Planning and Monitoring

A plan for the use of pesticides should cover the following points:

1. A statement of the specific vector problems to be addresses.
2. The key points of the safety plan described above. (The full safety plan should be an annex to the pesticide use plan.)
3. A justification for the use of specific chemicals and treatment methods, with alternative considered.
4. A review of any legal or regulatory requirements which need to be met during pesticide used.
5. A public information plan (based on and expanded from the safety plan).
6. An organization chart, with responsibilities of main staff noted.
7. A logistics plan covering the procurement, transport, processing (e.g., formulation, breaking large volumes of pesticide down to smaller application-level volumes), storage and disposal of containers and other materials. The logistics plan should include a spill management component if not covered in the safety plan.
8. A plan for monitoring the
    a. Application of the pesticides,
    b. Health conditions of applicators, pesticide handlers (including vehicle drivers), control program staff and populations in areas where pesticides are used,
    c. Impact on target vectors and non-target species.
9. A training plan, with materials in appropriate language identified.
10. A budget.

Pesticide Application Methods

- Dusting - Hand-held dusters, manually operated or mechanized.
- Residual insecticide - Knapsack sprayers with spraying special nozzles.
- Ultra-low volume - Low-dosage applications to spraying large areas from fixed-wing aircraft or helicopters.
- Space spraying - Interior or exterior applications with pesticide aerosols dispersed under pressure from vaporizers or fogging machines.
- Impregnation The treatment of materials such as bedding, clothing and mosquito nets with pesticides in emulsion or solution (by dipping and drying, or by spraying with knapsack sprayers).

From: *Box 10.2 Pesticide application methods and equipment for emergencies,* **Environmental Health in Emergencies and Disasters: A Practical Guide**.

Full details planning on chemical control program can be found in *Chapter 4, Overall Process for Implementing a Vector Control Programme,* **Emergency Control of Vectors Using Chemicals**.

Selecting the Correct Treatment Method and Chemical

The table at right summarizes the different ways to deliver pesticides in a vector control operation and the following table provides a summary of the best methods to use for the control of specific vectors.

The selection of the correct control chemical depends on a number of factors, including:

1. Funding – some pesticide formulations (e.g., wetable powders) are less expensive than others and some application methods are considerably more expensive than others.
2. Vector breeding and impact areas – Vectors which inhabit closed spaces (e.g. mice) require different chemicals and application methods than vectors which occupy open spaces (e.g. mosquitoes).
3. Area to be covered – localized use of chemicals is more appropriate for rodent control, while space application may be more appropriate for flying insects such as mosquitoes.
4. Urgency – if the need for vector control is immediate, then chemicals which can be used quickly, and which have a quick impact will need to be used.
5. Regulations – the selection and application of a vector control chemical needs to comply with government regulations and, in some cases, with possibly more restrictive regulations of those who are funding the application. These regulations may defined
    a. That only a single or a limited number of chemicals can be used to control a vector
    b. How these chemicals may be used (e.g., spaying, dusting) and
    c. The steps which need to be taken to limit unwanted impacts (e.g., prohibiting application near water bodies, or use in inhabited locations).

Considering the factors above, the first steps in selecting a vector control chemical are to:

1. Identify the vector to be controlled.
2. Identify what pesticides are authorized for control of this vector by national regulation or those of the program funder.
3. Refer to a pesticide application expert on the best methods and approaches to using chemicals for vector control. These experts may be available locally or through the World Health Organization (via WHOPES, see below) and the Food and Agricultural Organization (Pesticide Management Unit, Plant Protection Service).

The World Health Organization has developed a Pesticide Evaluation Scheme ("WHOPES" - https://www.who.int/neglected_diseases/resources/WHOPES/en/) as a source of information on the selection and use of public health related pesticides. WHOPES includes information on the effectiveness and use of specific pesticides, application equipment and methods, pesticide safety and links to other useful resources. WHOPES should be used as a primary source of information on the development of vector chemical control programs as well as in the selection of the most appropriate equipment and pesticides.

Further Information on the Web

There are a number of useful manuals and guidance on vector control on the Web. The reference sections of the documents listed below identify additional hard copy references on different aspects of vector control. The Web documents and hard-copy references should be consulted in planning and implementing vector control program.

Emergency Control of Vectors Using Chemicals, C. Lacarin and B. Reed, Water, Engineering and Development Centre, Loungborough University, 1999, http://wedc.lboro.ac.uk/resources/books/Emergency_Vector_Control_Using_Chemicals_-_Complete.pdf.

Handbook for Integrated Vector Management, WHO, 2012, https://apps.who.int/iris/bitstream/handle/10665/44768/9789241502801_eng.pdf;jsessionid=29E71D1213532ECFB2A47A58067B2B5F?sequence=1.

Integrated Pest Management (IPM) In and Around Buildings, Armed Forces Pest Management Board Technical Guide No. 29, Armed Forces Pest Management Board Information Services Division, Office of the Deputy Under Secretary of Defense (Installations & Environment) Ft. Detrick - Forest Glen Annex, Building 172, Forney Road Silver Spring, MD 20910-1230. Revised date: August 2009, https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg29.pdf.

National Pesticide Information Center, http://npic.orst.edu/pest.htm.

Pesticides and Their Application: For Control of Vectors and Pests of Public Health Importance, World Health Organizations 2006, http://whqlibdoc.who.int/hq/2006/WHO_CDS_NTD_WHOPES_GCDPP_2006.1_eng.pdf

UC IPM Online, Statewide Integrated Pest Management Program, http://www.ipm.ucdavis.edu/index.html.

Vector Control, Chapter 5a, Public Health Guide for Emergencies, S. Abdallah and G. Burnham, eds., The Johns Hopkins School for Hygiene and Public Health and The International Federation of Red Cross and Red Crescent Societies (no date), http://pdf.usaid.gov/pdf_docs/PNACU086.pdf.

Vector and Pest Control, Chapter 10, Environmental Health in Emergencies and Disasters: A Practical Guide, B. Wisner, J. Adams, World Health Organization, 2002, https://www.who.int/water_sanitation_health/emergencies/emergencies2002/en/.