Guidance on Microbial Contamination in Previously Flooded Outdoor Areas

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Problem Statement

Microbial contamination—both bacterial and viral—of flood waters can cause great concern for use of previously flooded outdoor areas. Limited guidance exists on how to determine safe use of these areas. This guidance was developed for public health authorities, emergency response managers, and government decision makers. This document defines how to assess the public health risks for using outdoor areas after a flood event where potential exposure to microbial contamination exists. This guidance is not intended to serve as a conclusive determination on public access and use of previously flooded outdoor areas.

Introduction and Background

After a flood event, questions arise about health risks associated with using outdoor areas such as ball fields, playgrounds, and residential yards. Microbial exposure is a concern because wastewater treatment plants, residential septic systems, municipal sanitary sewer systems, and agricultural operations can be affected by flood waters and can contaminate flooded areas. This document addresses concerns associated only with microbial contamination after a flood event. Chemical contamination issues associated with flood events are not addressed in this document.

Due to many variables, health authorities should characterize potential health exposure risks posed by flood waters on a case-by-case basis. Risk characterization involves identifying potential contamination sources, determining factors that may influence microbial concentration and survival, determining the potential effect on exposed populations, and considering the intended use for previously flooded outdoor areas. A discussion about safely occupying previously flooded areas is provided later in this document in the risk assessment section.

Flood waters commonly contain microbial contaminants and can directly affect public health. Increased levels of microbes in floodwaters increase the risk of human exposure and the likelihood for infection. A study (*1*) after Hurricane Katrina determined that microbial contaminants, specifically fecal coliforms, were elevated and considered consistent with levels detected historically in typical storm-water discharges in the area. A study (*2*) conducted during the Midwest flooding of 2001 identified an increased incidence of gastrointestinal illness during the flood event.

Microbes and Viability

Floodwater contaminated by microbes may contain bacteria, viruses, protozoa, and helminthes (*3*). Exposure to these pathogens can cause illnesses ranging from mild gastritis to serious diseases such as dysentery, infectious hepatitis, and severe gastroenteritis (*4*). The concentration of microbes in flood water depends on how many and what kind of sources contributed to the contamination, the volume of contaminants released and the degree of their dispersion in the environment, and the level of treatment of the affected wastewater-treatment facilities before the flooding (*3,5*).

Typically, it takes 2–3 months for enteric bacteria to significantly reduce in soil, with certain exceptions (*6*). Environmental factors including temperature, soil desiccation, pH, soil characteristics, and sunlight influence microbial survival and persistence (*5–9*). Microbial survival in soil and the resulting potential for human exposure is difficult to predict because of natural variability in those environmental factors and varying microbial susceptibilities. For example, shigella has survived in soil at room temperature for 9–12 days (*10*) and cryptosporidium oocysts may survive in a moist environment for 60–180 days (*3*). Spore-forming microbes such as coccidioides, a fungus that exists in semiarid southwestern U.S. soil (*11*), and anthrax spores can survive in soil for many years (*12*). Aside from the microbe's ability to survive, availability is another important factor to consider. Certain microbes can sorb to stable soil, which may lengthen their survival time.

Due to different microbial responses to the environment, providing universal guidance is difficult. Intensity of sunlight exposure, level of soil desiccation, and ambient temperatures necessary to effectively kill all microbes within a specified time varies among microbes. Survival characteristics for microbes under specified conditions have been reported, however generalizing study results proves more difficult. The scientific inability to generalize microbial viability reinforces the need to implement a risk-assessment approach that considers all variables that could influence potential exposure.

Control and Remediation

Exposure risk to microbes in soil after a flood event can be influenced by emphasizing the importance of personal hygiene. Public health education efforts should include personal hygiene precautions and guidance. Education efforts should emphasize proper handwashing and adequate handwashing and drying supplies and equipment in public restrooms and at temporary handwashing facilities should be provided. Education efforts should include cautions to avoid standing water, areas saturated with floodwater, and areas with visible debris. Those areas create concern for microbial exposure and may also cause public safety concerns.

Signs may be used to indicate public health and safety concerns and to discourage use of potentially hazardous areas. Intended use of outdoor areas (e.g., grass-covered high school soccer field versus daycare outdoor play area), with special consideration for areas where young children are likely to play, should be determined and considered. For example, sand in sandboxes and soil, mulch, and wood chips around outdoor playground equipment may need to be removed. All outdoor items with cleanable surfaces that were in contact with flood water should be adequately cleaned before they are used.

Small areas of gross contamination (i.e., sewage with visible solid material) should be cleaned, and treatment with hydrated lime may be considered. Hydrated lime can be applied to increase pH to a level that kills microbes. The U.S. Environmental Protection Agency (EPA) requires that the pH of sewage sludge treated for land application be held at 12 for a minimum of 2 hours to kill microbes, and be held at a minimum of 11.5 for 22 additional hours to reduce vector attraction (*13*). In addition to maintaining an adequate pH level, sludge dryness can affect how easily and quickly microbes die (*14*). Applying quicklime, which can help dry areas of gross contamination, may be considered. The National Lime Association promotes using quicklime to expedite drying of mudded areas (*15*).

Of significance, the pH level requirements discussed earlier pertain to treating sewage sludge and not soil. Lime effectiveness for treating microbial-contaminated soils was not proven during literature review. Wide-scale application of lime could affect human health and the environment, which could outweigh potential risks posed by a flood event. Exposure to hydrated or quicklime may be hazardous to applicators and the public. Exposure routes include inhalation, ingestion, and skin or eye contact. Exposure to hydrated or quicklime may cause irritation to skin, eyes, upper respiratory system, skin vesiculation, cough, bronchitis, and pneumonitis, and may burn eyes and skin (*16*).

If lime is applied in small, heavily contaminated areas, applicators should wear appropriate personal protective equipment as required by occupational health and safety regulations and described in the manufacturer's Material Safety Data Sheet and product label. In addition to health hazards, the inappropriate use of lime can cause damage to personal property (*17*). Environmental effects may include damaged vegetation (increasing potential for soil erosion), excessive soil dehydration, and lime in run-off waters.

Other remedial and control options may be considered. Exposure to potential pathogens in soil may be controlled by

- depositing new soil on top of the affected soil and compacting,
- planting new grass,
- watering to flush organisms out of the upper soil layers,
- covering the affected ground with asphalt, brick, stone, cement, or other solid paving material, and
- applying dust-suppressant products where air dispersion is a concern.

Risk-assessment Approach

After a flood event, health authorities should assess human health risk by using a systematic approach because many variables must be considered. Following a risk-assessment process will help authorities determine how to safely use previously flooded outdoor areas.

The four steps of the risk-assessment process (*18*) (Figure 1; see page 7) are

1. <u>Hazard identification</u>: determines if adverse health effects may be caused by exposure to the contaminant (Can the contaminants found affect human health?).
2. <u>Dose-response assessment</u>: examines the magnitude of the exposure and probability of adverse health effects (Are contaminants found to the extent that can affect health?).
3. <u>Exposure assessment</u>: measures or estimates the extent of human exposure to the contaminant (Who may be exposed, for how long or how frequently, and how much?).

4. Risk characterization: interprets information from the proceeding steps to form an overall conclusion about human risk.

This comprehensive approach also considers risks to flora and fauna, and the effect of remedial action on human health and the environment.

Conclusion

Determining when to allow use of previously flooded public areas requires analyzing and considering many variables. This guidance is intended to help health authorities assess the level of risk posed by microbial contamination after a flood event. This guidance is not intended to represent all variables that should be considered—any flood event may present many complexities. The following flow chart may help prompt discussion and consideration of various risk factors.

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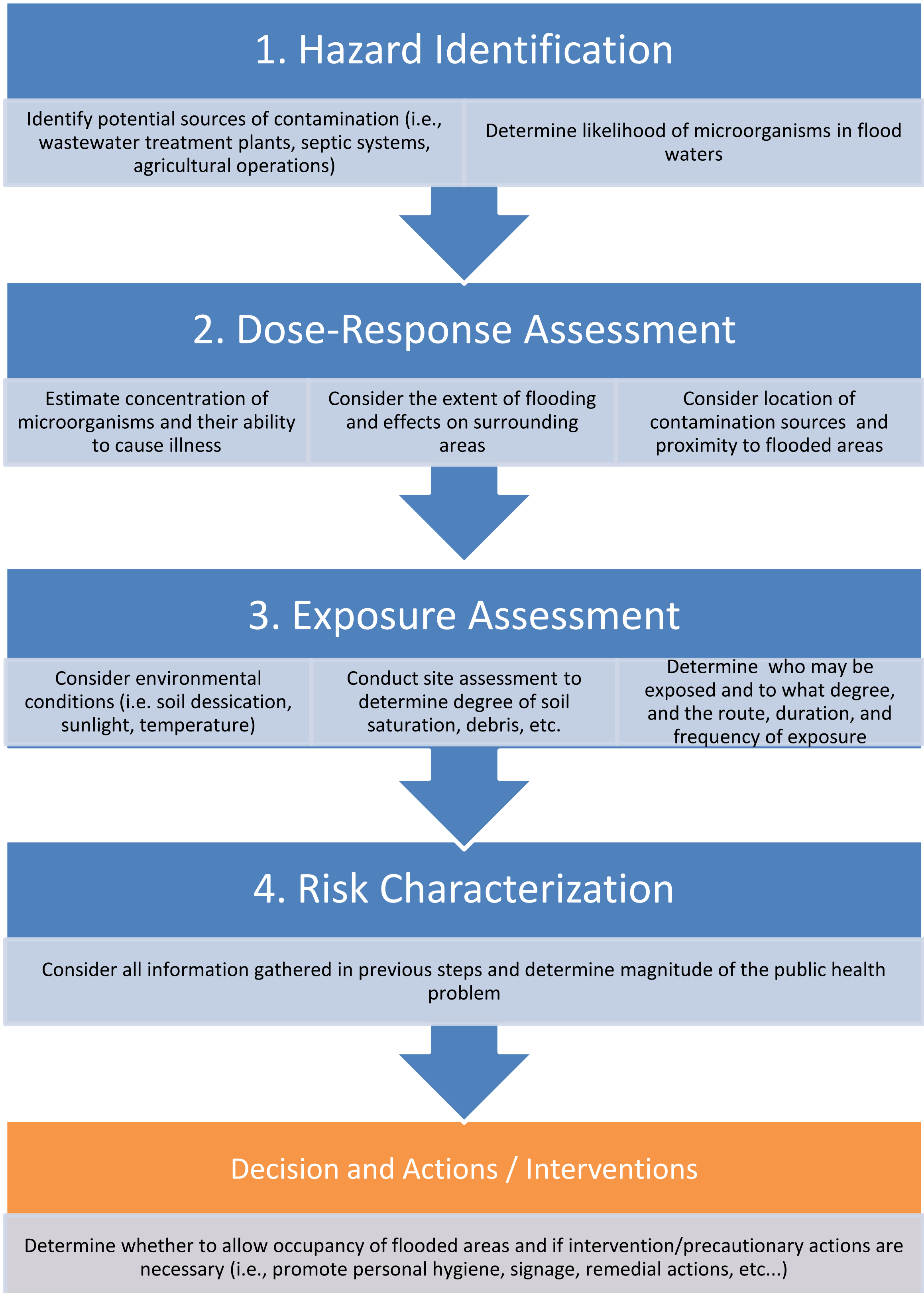

Figure 1. The Four Steps of the Risk-assessment Process (*18*)