

Michael J. Hayes*
University of Nebraska, Lincoln, Nebraska

1. INTRODUCTION

People often consider developing nations when they think about public health impacts from drought. Certainly, there are some very acute public health problems caused by droughts and famines in the developing nations around the world that have captured headlines in the press. However, public health impacts can also occur in the developed nations as well, as the 2002 drought in the United States has illustrated. This drought has provided numerous examples demonstrating the variety and seriousness of public health impacts related to drought. Officials need to plan for these impacts and develop mitigation actions to reduce these impacts in the future.

In general, drought impacts can be described as falling into three large categories: economic, environmental, and social. The public health impacts fall under the social category. At least nine basic public health issues related to drought have been identified. These issues are 1) water quality, 2) waste treatment, 3) water quantity, 4) mental health and stress, 5) dust and windblown agents, 6) wildlife intrusion, 7) increased rodents and pests, 8) nutrition, and 9) hygiene.

2. WATER QUALITY AND QUANTITY IMPACTS

Perhaps the most obvious public health impact is on water quality, and the affect on waste treatment released in streams and reservoirs is a subset of this. As water levels fall, the concentration of chemicals, effluent, and pathogens can become much greater, having an impact on the drinking water quality of municipal water systems and domestic wells, as well as lakes and rivers where humans have contact with the water, usually through recreational uses.

Denver Water, which serves the city of Denver, CO, had a surprise water quality impact result from the Hayman Fire that took place in June 2002. Because much of their water supply comes through the burned area, runoff due to rains afterward caused Denver Water to have the following caution on their web site: "The water runoff...may cause your water to have a smoky/ashy, moldy, dirty, musty, earthy, maybe even astringent taste" [http://www.water.denver.co.gov/Taste_odor.html, August 8, 2002], although it was still considered safe to drink. Likewise, Phoenix, AZ, officials are watching how ash washing into the Salt River from the 468,000 acre Rodeo-Chediski fire in June 2002 might affect their water supply in the upcoming months (U.S. Water News, 2002).

Water quantity impacts are also a public health concern and homeowners with private wells are most at

risk. South Carolina and Georgia have had ongoing problems with dry domestic wells since their drought began in 1998. During the summer 2000 in southwestern Georgia, 800 domestic wells failed and 18-20 small municipal systems failed (Blood 2001). The private wells for approximately 17,000 families in Maine became dry at some point during the 2001-2002 drought there, with waiting lists for new wells up to six months long (Governor Angus King, letter to President Bush, 4/9/02).

The National Center for Environmental Health estimates that the water requirements for individuals are at least 15-30 liters per person per day, with 3-5 liters per person per day as an absolute minimum (Keim 2001). These needs increase as the air temperature increases, which frequently happens during drought events. The greatest concern is for the most vulnerable populations such as in hospitals and nursing homes, but having enough water for municipal fire fighting has also been a major concern for several communities in the U.S. because of low water levels and pressures related to drought during the past several years.

3. MENTAL HEALTH AND STRESS IMPACTS

These public health impacts are some of the least known, but they have been receiving increased attention during the drought in 2002. Impacts include suicide, abuse, increased illness, stress, sleeplessness, and physical injuries due to stress and fatigue.

The agricultural industry certainly bears a large brunt of the mental health and stress problems resulting from drought. Of 130 high stress occupations, farming ranks as the 12th most stressful (Selzler 2001). Adding drought to the long-term stress associated with farming may push farmers beyond their physical and mental capacities to cope with stress. Children, elderly, and minority ethnic groups within an agricultural community may be particularly at risk for these types of impacts. For the minority groups, language barriers can create an additional source of frustration and stress. Ranchers faced with liquidating large parts of their herds due to a lack of water or forage are placed under a tremendous emotional, as well as financial, burden.

Both South Dakota and Nebraska have targeted farmers and farm families with mental health information that is available on web sites during the 2002 drought. South Dakota State University has placed a series of 12 stress-related publications on their web site [<http://sdces.sdstate.edu/drought/>]. The University of Nebraska's Cooperative Extension Service has provided a similar service [<http://ianrhome.unl.edu/drought/>]. Nebraska's Department of Agriculture has also activated a farm crisis hotline during both the 2000 and 2002 droughts.

* Corresponding author address: Michael Hayes, National Drought Mitigation Center, 241 Chase Hall, Lincoln, NE 68583-0749; e-mail: mhayes2@unl.edu.

4. IMPACTS FROM DUST AND WINDBLOWN AGENTS

Wildfires are a pretty visible and dangerous impact from droughts, but few people realize that the smoke from wildfires can also be a significant public health hazard related to drought. Increased dust and allergens as a result of drought can also create a hazard, particularly for individuals with asthma and other respiratory disorders. Approximately 8-10% of Americans have asthma (Sherard 2001).

The wildfires in Montana caused by drought in 2000 had a significant impact for people and livestock across Montana and North Dakota. One result of these fires and the resulting smoke was the development of a rating scheme shown in Table 1 to communicate the hazards of smoke and poor air quality to the public during wildfires and/or droughts (Wyoming Department of Health Subcommittee 2001).

5. IMPACTS FROM WILDLIFE INTRUSION, RODENTS, AND PESTS

Humans are not the only ones to experience hardships because of the lack of water caused by drought; wildlife also suffers. Droughts frequently cause wildlife to search for sources of water far beyond their normal territory, increasing the possibility for potentially dangerous contact with humans. The droughts in recent years in the United States have provided many examples of wildlife intrusion problems, frequently surprising local officials that have to deal with these problems. As animal contact with humans and their pets increases, rabies, as one example, becomes a greater concern.

The examples of wildlife intrusion impacts related to droughts in the U.S. in recent years include: alligators in Florida and Georgia in swimming pools, golf water hazards, beaches, and along other bodies of water where they are not expected; snakes in North Carolina; mountain lions or cougars across the western U.S.; black bears or grizzly bears in many areas; and the highly publicized problem of rats in Los Angeles and particularly Hollywood. Wildlife intrusion can also have a significant impact on agricultural production—for example, large populations of deer or elk moving into corn or alfalfa fields to eat, adding to the additional stress farmers are facing from drought situations.

Droughts also have an impact on rodents and pests. Drought, for example, may increase contact between humans and the rodents that are infected with the Hantavirus. The recent spread of the West Nile Virus across the U.S., and the publicity this has generated, may also be indirectly related to droughts. In Wyoming, where plague is endemic within the prairie dog populations, health officials there have been concerned about the greater interaction between the animals and humans during the recent drought years in that state. Other pests, such as ants, also cause additional problems as they seek water as well. Nebraska and several other states have had severe grasshopper infestations during 2002 that have dealt an additional blow to farmers dealing with drought losses.

6. NUTRITION AND HYGIENE IMPACTS

These two impacts are the major public health impacts related to drought in the poorest nations. However, in developed nations they can also have an impact as well, most often related to the other public health impacts already mentioned. For example, if a family is hauling water to their home because the domestic well has gone dry, nutrition and hygiene are probably both going to suffer as the family tries to use as little water as possible. In addition, as stress increases, nutrition and hygiene also tend to suffer. Physical health might also be affected because of decreased water consumption and the physical strain caused by hauling large amounts of water. Public health officials need to be very aware of these potential impacts as they work with people experiencing water supply shortages and severe stress because of droughts.

7. CONCLUSIONS

The 2002 drought across large parts of the United States has provided numerous examples of public health-related impacts due to drought. In the past, officials have not given much attention to this set of impacts. But because more information is now available, and lessons learned from various drought events are becoming better known, opportunities to quickly respond to these impacts, or even mitigate or lessen their severity before drought occurs, are becoming more available.

Some of the lessons emerging from the impacts seen around the U.S. are that clear communication and readily available public information are essential in reducing public health impacts resulting from droughts. In addition, faith-based resources and organizations, as well as other community networks, can provide important opportunities and networks for communication and information. Likewise, school programs that deal with issues such as drought, water, and public health can also be very effective in reducing some of the impacts that might occur related to drought events. Officials should use these lessons and incorporate these actions and others into the state and local drought plans around the country to reduce the public health drought risk in the future.

8. REFERENCES

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Table 1. Example Air Quality Rating Scheme for Smoke from Wildfires.

Conditions	Health Effects	Cautionary Statements	Visibility Ranges	1 hour PM₁₀
Good	None.	None.	10 miles and up	0-40
Moderate	Possibility of aggravation of heart or lung disease among persons with cardio-pulmonary disease and the elderly.	Extremely sensitive people should consider limiting prolonged outdoor exertion.	4 to 9 miles	41-80
Unhealthy for Sensitive Groups	Increasing likelihood of increased respiratory symptoms in children and adults, aggravation of heart or lung disease and premature mortality in persons with cardio-pulmonary disease and the elderly.	People with respiratory or heart disease, the elderly, and children should limit prolonged exertion.	2¼ to 3 miles	81-175
Unhealthy	Increasing respiratory symptoms in children and adults, aggravation of heart and lung disease and premature mortality in persons with cardio-pulmonary disease and the elderly.	People with respiratory or heart disease, the elderly, and children should avoid prolonged exertion; everyone else should limit prolonged exertion.	1¼ to 2 miles	176-300
Very Unhealthy	Significant increase in respiratory symptoms in children and adults, aggravation of heart disease and premature mortality in persons with cardio-pulmonary disease and the elderly.	People with respiratory or heart disease, the elderly, and children should avoid any outdoor activity, everyone else should avoid prolonged exertion.	1 mile	301-500
Hazardous	Serious risk of respiratory symptoms in children and adults, aggravation of heart and lung disease and premature mortality in persons with cardio-pulmonary disease and the elderly.	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly, and children should remain indoors.	¾ miles or less	>500