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Climate Change–Related Water Disasters' Impact on Population Health

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Abstract

Purpose: Rising global temperatures have resulted in an increased frequency and severity of cyclones, hurricanes, and flooding in many parts of the world. These climate change–related water disasters (CCRWDs) have a devastating impact on communities and the health of residents. Clinicians and policymakers require a substantive body of evidence on which to base planning, prevention, and disaster response to these events. The purpose of this study was to conduct a systematic review of the literature concerning the impact of CCRWDs on public health in order to identify factors in these events that are amenable to preparedness and mitigation. Ultimately, this evidence could be used by nurses to advocate for greater preparedness initiatives and inform national and international disaster policy.

Design and Methods: A systematic literature review of publications identified through a comprehensive search of five relevant databases (PubMed, Cumulative Index to Nursing and Allied Health Literature [CINAHL], Embase, Scopus, and Web of Science) was conducted using a modified Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach in January 2017 to describe major themes and associated factors of the impact of CCRWDs on population health.

Findings: Three major themes emerged: environmental disruption resulting in exposure to toxins, population susceptibility, and health systems infrastructure (failure to plan-prepare-mitigate, inadequate response, and lack of infrastructure). Direct health impact was characterized by four major categories: weather-related morbidity and mortality, waterborne diseases/water-related illness, vector-borne and zoonotic diseases, and psychiatric/mental health effects. Scope and duration of the event are factors that exacerbate the impact of CCRWDs. Discussion of specific factors amenable to mitigation was limited. Flooding as an event was overrepresented in this analysis (60%), and the majority of the research reviewed was conducted in high-income or upper middle-/high-income countries (62%), despite the fact that low-income countries bear a disproportionate share of the burden on morbidity and mortality from CCRWDs.

Conclusions: Empirical evidence related to CCRWDs is predominately descriptive in nature, characterizing the cascade of climatic shifts leading to

major environmental disruption and exposure to toxins, and their resultant morbidity and mortality. There is inadequate representation of research exploring potentially modifiable factors associated with CCRWDs and their impact on population health. This review lays the foundation for a wide array of further areas of analysis to explore the negative health impacts of CCRWDs and for nurses to take a leadership role in identifying and advocating for evidence-based policies to plan, prevent, or mitigate these effects.

Clinical Relevance: Nurses comprise the largest global healthcare workforce and are in a position to advocate for disaster preparedness for CCRWDs, develop more robust environmental health policies, and work towards mitigating exposure to environmental toxins that may threaten human health.

Widespread scientific consensus exists that the world's climate is changing (Crimmins et al., 2016; Portier et al., 2010; Woodward et al., 2014), and as a direct result of climate change, water-related disaster events are increasing in frequency and intensity. Over the past half century, the persistent burning of fossil fuels has released sufficient quantities of carbon dioxide and other greenhouse gases to trap additional heat in the lower atmosphere. Rising greenhouse gas concentrations have resulted in the earth becoming progressively warmer each decade (World Health Organization, 2017). As a result, there have been more variable hydrologic events (glaciers melting, heavy precipitation, general flooding, flash flooding, and coastal floods) and meterologic events such as cyclones, hurricanes, tropical storms, and sea level rise. Each of these events has the potential to negatively affect the health of populations across the globe. While climate change is a public health issue, the effects of climate change will vary across geographic regions and populations (Crimmins et al., 2016). Some degree of climate change is unavoidable, and we must adapt to its associated health effects; however, aggressive mitigation actions can significantly blunt the worst of the expected exposures (Interagency Working Group on Climate Change and Health, 2016). The scientific evidence to support climate change is strong, yet contentious international political debate persists regarding what actions to take in response. Nurses represent the largest global healthcare resource and, as such, are ideally suited to contribute to disaster preparedness efforts for climate change–related water disasters (CCRWDs), build sustainable communities, advocate for more robust environmental health policy, and work towards mitigating exposure to environmental toxins that may threaten human health.

Public health officials, clinicians, and policymakers require a substantive body of evidence on which to base interventions and disaster response initiatives if they wish to effectively plan, prepare for, and mitigate the impact of cyclones, floods, hurricanes, and sea level rise on global populations. The purpose of this study was to conduct a systematic review of the literature concerning CCRWDs. Ultimately, this evidence will be useful to inform national and international environmental disaster policy in this area.

Methods

Search Strategy

In order to capture the broad scope of variables impacting public health as a result of CCRWDs, a systematic review of the literature was conducted using a modified Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach (PRISMA, 2015). This framework provides for a guided search and review method with prespecified inclusion and exclusion criteria, definition of terms, and documentation of selection decisions, as recommended by Kastner et al. (2012) and Moher, Liberati, Telzlaff, Altman, and the PRIMSA Group (2009). A systematic review is a review of a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyze data from the studies that are included in the review. Statistical methods (meta-analysis) may or may not be used to analyze and summarize the results of the included studies (Moher et al., 2009).

Our research team collaborated with an experienced medical research librarian to design a rigorous protocol that would identify all peer-reviewed published literature on the public health impact of CCRWDs as outlined in **Table 1**. Databases searched included PubMed, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Embase, Scopus, and Web of Science in order to provide information from a variety of disciplines. Climate change as a topic was searched by using the terms climate change, climatic processes, El Niño-Southern Oscillation, and global warming. Disaster as a topic was searched using the terms disaster, natural

Table 1. Search Strategy

	Terms	PubMed	CINAHL	Embase	Scopus	Web of Science
A	Climate change OR climatic processes OR El Niño-Southern Oscillation OR global warming	43,144	3,788	31259	206,935	145,523
B	Disasters OR natural disasters, OR cyclones OR hurricanes OR floods	28,334	14,722	42,449	325,012	124,573
C	[A + B]	659	422	2,798	16,090	11,577
D	Health (population OR public OR community)	846,571	336,933	792,871	553,629	420,604
E	[A + B + D]	306	115	254	430	251

Note. CINAHL = Cumulative Index to Nursing and Allied Health Literature.

disasters, cyclone, hurricane, and floods. Public health as a topic was searched using the terms public health, community health, and population health.

The initial search strategy identified 1,356 published works (**Figure 1**). Duplicates were removed (551), and the titles and abstracts of the remaining 805 published works were reviewed by the research team for relevance to the question at hand. Of these, 758 articles were removed because they did not meet the inclusion criteria (articles were not specific to water-related disaster events, were not human focused, did not address health, or were not peer reviewed). In total, 47 articles met inclusion criteria and were retained for analysis. For an overview on articles by country income, global region, or types of water-related disaster, see Figures S1 and S2 and Table S1. Thematic analysis was conducted to identify the key concepts or major themes, and a second round of analysis was conducted to identify subthemes and factors associated with health impact that may be amenable to mitigation. The two-tiered review of the articles supported many previously identified trends in the literature, and no new ideas surfaced, indicating that thematic saturation had been achieved.

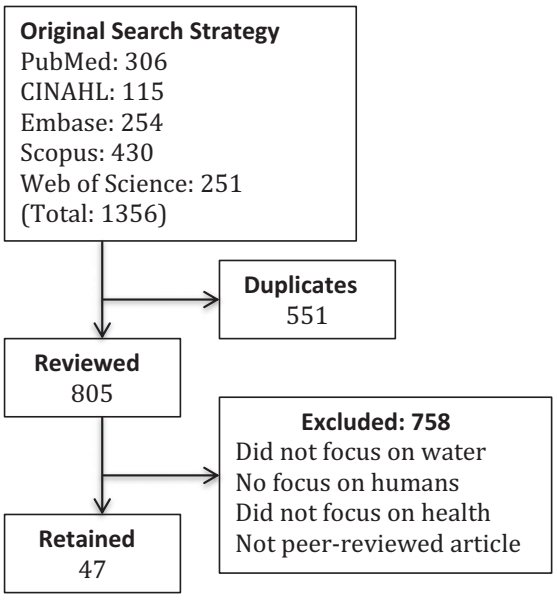

Figure 1. Inclusion scheme.

Table 2. Inclusion and Exclusion Criteria

Search terms	
Climate change, climatic processes, El Niño, global warming	
Disasters, natural disasters, floods, flash floods, coastal floods, flooding, cyclone, hurricane, heavy rainfall/precipitation, sea-level rise	
Health (population OR public OR community)	
Inclusion criteria	**Exclusion criteria**
Published in a peer-reviewed publication	Outside the peer-reviewed publications
Focus on health (population, public, community)	Focus on other disasters (earthquakes, wildfires, heat waves, drought, etc.)
	Focus not on health
Purpose of the study was to identify impact of climate change related water disasters upon population health	Focus on animals/insects
Focus on human health	Focus on infrastructure, engineering, or agriculture
Dates Limited to 2006–2016	Publication date prior to 2006
English language	Non-English language

Inclusion Criteria

In order to be included in this review, the publication must have focused on the impact on public health resulting from CCRWDs; the criteria and definitions given below were used in this review. To ensure timeliness and relevance, studies were restricted to the past 10 years (2006–2016) and had to be published in the English language. Exclusion criteria included articles that were not published in peer-reviewed publications, focused on other disasters (earthquakes, wildfires, heat waves, drought, etc.), did not focus on health, focused on animals or insects, or focused on infrastructure, engineering, or agriculture. A summary of inclusion criteria, exclusion criteria, and the selection process is depicted in **Figure 1** and **Table 2**.

Definitions

Climate change. Climate change was defined as local or global progressive variations in annual weather patterns and characteristics.

Disaster. Disaster was defined as any event that overwhelms the local or regional capacity to respond or any situation that exceeds the region's response resources.

Susceptibility. Susceptibility was defined as having the potential to be influenced or harmed by an event or threat.

Toxins. Toxins were defined as poisonous substances that are specific products of the metabolic activities of a living organism and are usually very unstable, notably toxic when introduced into the tissues, and typically capable of inducing antibody formation.

Mitigation. Mitigation was defined as those measures that eliminate or reduce the impacts and risks of hazards through proactive measures taken before an emergency or disaster occurs.

Environmental disruption. Environmental disruption was defined as the deterioration of the environment through alterations in natural resources such as air, water, and soil; the destruction of ecosystems; habitat destruction; the extinction of wildlife; and pollution.

Population susceptibility. Population susceptibility was defined as a group of individuals who have an identifiable common characteristic for which the rate and magnitude of response or type of health outcome differs (or could reasonably be expected to differ) from that of a reference population.

Data Evaluation and Study Quality

The authors independently assigned an evidence level and corresponding quality grade as outlined by Dearholt and Dang (2012). Evidence levels were defined as follows:

Level I: experimental study, randomized controlled trial
Level II: quasi-experimental study
Level III: nonexperimental study
Level IV: opinion of respected authorities or nationally recognized expert committees or consensus panels
Level V: based on experiential and nonresearch evidence

In order to assess the quality of these studies, the authors used the critical appraisal tool as outlined by Crowe and Sheppard (2011) and Crowe, Sheppard, and Campbell (2012), which yields a score between 0 and 40. This tool is best utilized for studies with evidence levels I to III and, as such, was not used to review works graded as level IV or V. Each author independently graded each article using this tool. Scores were then combined and averaged if they did not deviate by more than 5 points. If scores differed by more than 5 points, the authors reevaluated the material together in order to determine the score.

Findings

Three major themes emerged: environmental disruption resulting in exposure to toxins, population susceptibility, and health systems infrastructure (failure to plan-prepare-mitigate, inadequate response, and lack of infrastructure). Population health impact was characterized in four major categories: weather-related morbidity and mortality (drowning, electrocution, cerebrovascular accident), waterborne diseases/water-related illness, vector-borne and zoonotic diseases, and psychiatric/mental health. Scope and duration of the event are factors that exacerbate the impact of CCRWDs.

Environmental Exposure to Toxins

Weather-related morbidity and mortality. The health impacts of CCRWDs can be severe, and include direct impacts such as drowning, electrocution, cardiovascular events, and mental health effects. Displacement by flooding leads to sheltering in close quarters, creating unsanitary living conditions, perpetuating infectious disease spread (Abaya, Mandere, & Ewald, 2009).

Waterborne diseases. Increases in water temperature, precipitation frequency and severity, evaporation–transpiration rates, persistent humidity, and changes in coastal ecosystems increase the incidence of water contamination with harmful pathogens and chemicals, resulting in increased human exposure and waterborne disease (Ahmed, Scholz, Al-Faraj, & Niaz, 2016; Alderman, Turner, & Tong, 2012; Davies et al., 2015; De Man et al., 2014; Dura et al., 2010; Gao, Zhang, Ding, Liu, & Jiang, 2016; Kang et al., 2015; Lin, Wade, & Hilborn, 2015; Phung et al., 2015; Wade, Lin, Jagai, & Hilborn, 2014). Flooding events in particular increased the incidence of the following three diseases: hepatitis A virus (Gao, Zhang, Ding, Liu, & Jiang, 2016, Gao, Zhang, Ding, Liu, Wang, & Jiang, 2016), bacillary dysentery (Liu, Liu, Zhang, & Jiang, 2016; Liu, Li, et al., 2016; Lin, Wade, & Hilborn, 2015; Ni, Ding, Li, Li, & Jiang, 2014; Ni, Ding, Li, Li, Liu, & Jiang, 2014; Zhang, Ding, Liu, Zhang, & Jiang, 2016), and Campylobacter (Soneja et al., 2016).

Vector-borne and zoonotic diseases. Disease risk increases as a result of climate change due to related expansions in vector numbers and ranges, shortening of pathogen incubation periods, and disruption and relocation of large human populations (Portier et al., 2010). Vector-borne diseases include dengue, dengue hemorrhagic fever, yellow fever, West Nile virus (Ahmed et al., 2016; Alderman et al., 2012; Burton, Rabito, Danielson, & Takaro, 2016; Phung et al., 2014), Japanese encephalitis (Zhang, Liu, Zhang, & Jiang, 2016), Ross River virus (Tall, Gatton, & Tong, 2014), and malaria (Alderman et al., 2012; Boyce et al., 2016; Ding et al., 2014; Gao, Zhang, Ding, Liu, Wang, & Jiang, 2016).

Psychiatric and mental health. Psychological effects such as post-traumatic stress disorder (PTSD) in addition to other mental health sequelae have been noted after water-related disasters (Lane et al., 2013; Su, 2011), and the mental health effects of disasters are related to the intensity of the exposure to that disaster. In the wake of a disaster such as Hurricane Sandy, death, displacement, and psychosocial stress brought on by a loss of life and/or property are risk factors for PTSD, depression, and anxiety. Of these, PTSD has been the most studied with regards to disasters, usually an acute, disruptive event with an unpredictable scope and aftermath. PTSD can be caused by or exacerbated by events related to water-related disasters, including living through the disaster or by consequence of its impact (such as being involved in an evacuation or feeling the strain of the healthcare provisions afterwards; Nitschke et al., 2006). The rates of psychological distress and PTSD remained higher among people in flooded homes compared to those in non-flooded homes up to 6 months after the incident. Depression symptoms, for example, were eight times higher among people in flooded homes (Azuma et al., 2014).

Storms such as Hurricane Sandy also disrupt infrastructure and traditional systems of care, including mental health care that could mitigate the psychological toll of the event for victims. The mental health burden of care post-disaster requires ongoing preparedness and early warning systems to identify individuals at risk. Local and federal organizations may consider establishing evidence-based strategies for trauma and recovery to prevent mental health problems and chronic disability stemming from these problems after a disaster (Neria & Schulz, 2012).

A key recommendation was to monitor the impact of flooding on the health and well-being of those displaced, emphasizing the need for ready access to mental health care among the affected. Establishing local recovery groups and enlisting the aid of community networks to mitigate the physical and psychological damage from a flood event are paramount among preventive and intervention strategies (Gray, 2008).

Population Susceptibility

Individual susceptibility. Susceptibility of individuals, communities, and countries was described in many of the articles. Risk factors that increase susceptibility to greater impact from CCRWDs include living in poverty, living in unstable dwellings, and lacking access to health care (Alderman et al., 2012; Bloetscher et al., 2016; Burton et al., 2016; Dressler, Allison, Broach, Smith, & Milsten, 2016; Grabich, Horney, Konrad, & Lobdell, 2016; Khan, Gruebner, & Kraemer, 2014; Lane et al., 2013; Rodriguez-Llanes, Ranjan-Dash, Mukhopadhyay, & Guha-Sapir, 2016; Schmeltz et al., 2013; Srikuta, Inmuong, Inmuong, & Bradshaw, 2015). There is a strong correlation between social and health vulnerability as measured by lack of income, percentage of minority residents, lower educational attainment, lack of English fluency, low take up of medical services, age, and disability status (Bloetscher et al., 2016).

Males are more susceptible to drowning (the largest cause of mortality from cyclones), and males are most susceptible to dying from cyclones (Doocy, Dick, Daniels, & Kirsch, 2013). Other factors that were associated with susceptibility include being female, being very young or elderly, living with a disability, being an ethnic minorities, lacking fluency in the country's primary language, having a female head of household, and having lower educational attainment (Abbas & Routray, 2014; Alderman et al., 2012; Bloetscher et al., 2016; Burton et al., 2016; Grabich et al., 2016; Khan et al., 2014; Lane et al., 2013; Rodriguez-Llanes et al., 2016; Schmeltz et al., 2013; Srikuta et al., 2015). Children are more susceptible to injuries, diarrheal diseases, and respiratory infections (Phung et al., 2014). The incidence of severe wasting and stunted growth among children in regularly flooded regions in rural eastern India was significantly higher than among children in areas not regularly flooded (Rodriguez-Llanes et al., 2016). There was a lower incidence of diarrheal diseases associated with those who lived with piped water and toilets in Cambodia (Davies et al., 2015).

Nonfatal injuries and exacerbation of chronic illness are the leading causes of morbidity among residents and relief workers (Alderman et al., 2012). Individuals with ongoing health concerns or pre-existing conditions are susceptible to interruption of health care (Alderman et al., 2012) and may have exacerbations of their conditions during flood disasters (increase in cardiovascular disease during flood seasons in Canada

during flood years; Vanasse et al., 2016). Studies identified susceptibility resulting from proximity to the hazard, such as living in burgeoning coastal communities (Grabich et al., 2016; Lane et al., 2013) or living close to industrial and waste incineration plants (Azuma et al., 2014).

Community susceptibility. Communities with limited resources and those in lower income countries are more susceptible to water-related disasters and have poorer outcomes after disasters (Alderman et al., 2012), and the growth of coastal populations increases the morbidity and mortality of cyclones and the impact they have on global regions (Doocy et al., 2013; Grabich et al., 2016). Warm and humid climates promote microbe growth and exaggerate water-related and waterborne diseases in the area (Ahmed et al., 2016). The health impacts of coastal storms present challenges for cities like New York, a huge metropolis that is heavily dependent on transportation, has energy infrastructure vulnerable to flood damage, and has high-rise residential housing (Lane et al., 2013). Environmental and individual risk factors and symptoms were exacerbated by close proximity to industrial and waste incineration plants (Azuma et al., 2014).

Disruption in food or water sources. Climate change has made agricultural planning difficult due to erratic and unpredictable weather patterns. Crop yields have decreased as a result of climate change (Abaya et al., 2009). Floods have destroyed protected springs and wells, disrupted organic and inorganic material balance, degraded soil, and threatened water quality (Abaya et al., 2009, Ahmed et al., 2016). One of the main health effects of flooding is contamination of drinking water (Burton et al., 2016). Contamination of drinking water was the largest contributor to spreading Vibrio and Leptospira (Cann, Thomas, Salmon, Wyn-Jones, & Kay, 2013). Extreme rainfall events also contribute to the microbiological contamination of water source and supply, pose a risk to public health (Dura et al., 2010), and result in changes in salinity, chemical contamination, hygienic condition, pathogen contamination, nutrient cycling, and algal blooms (Phung et al., 2015). Flooding causes rapid loss of life from physical damage of the disaster but also interrupts food supply and life support, leading to chronic community malnutrition (Su, 2011). Communities that lack health infrastructure or health facilities have poorer health outcomes due to the interruption in transportation that is associated with flooding or other water-related disasters—people cannot get health care during communication or power disruptions (Abbas & Routray, 2014). Food security is related to increased population growth rates, deficiency of drinking water, degradation of soil, urbanization, and animal-based diets, all of which are influenced by climate change (Ahmed et al., 2016).

Health Systems Infrastructure

The effects of a water-related disaster spread beyond the time of the disaster and into the recovery period, disrupting health infrastructure and interrupting continuity of healthcare services (Alderman et al., 2012). Failure to plan or prepare and mitigate the effects of CCRWDs and failure to respond in a timely manner result in increased severity in health impact. Response efforts are hampered by a lack of health services and adequate health professionals in the area—poorer areas lack infrastructure to prevent or mitigate floods (no warning systems, boats, swimmers, life jackets; Abaya et al., 2009). Failure to prepare for extreme precipitation and flooding may pose significant challenges to curbing waterborne disease transmission (De Man et al., 2016) and malaria control programs and demands rapid responses to mitigate deleterious impacts on human health (Boyce et al., 2016). Preparation and early warning systems are key to preventing deaths and injuries from cyclones (Doocy et al., 2013).

Lack of infrastructure and damage to existing infrastructure also contribute to increased severity of disaster impact. Tropical storms and cyclones can affect public health infrastructure by damaging equipment, interrupting services, and disrupting access to clean water (Ryan et al., 2015). Infrastructure that is not intended to hold rainwater is inadequate to properly protect individuals from the communicable threats of waste water from flooding and disasters (De Man et al., 2014; Dura et al., 2010). Specifically, disruptions to the healthcare system and infrastructure as a result of hurricanes and tropical storms may have deleterious effects on pregnancy and birth outcomes (Grabich et al., 2016).

Local communities will face the greatest burden of initial response until national or international organizations arrive—local responses to Hurricane Sandy in Brooklyn mobilized volunteers to provide hot meals and deliver medicine and ice to homebound people, and distribute information and resources to community members for 3 weeks before government officials arrived (Schmeltz et al., 2013). Suggestions to improve the resilience of health systems include establishing standard operating procedures (Van Minh et al., 2014), ensuring a functional workforce (Ryan et al., 2016), establishing policy and land use mechanisms, setting mandatory disaster plans for hospitals, assessing current flood and environmental disaster strategies, and being aware of the social inequities

that enhance vulnerability to flood-related health problems (Burton et al., 2016).

Discussion

Increases in the incidence and intensity of extreme weather events such as hurricanes, floods, cyclones, and tropical storms adversely affect people's health immediately during the event or later following the event (Portier et al., 2010). Flooding as an event was over represented (60%) in the total literature reviewed. The majority of the research in this analysis was conducted in high-income or upper middle-to-high-income countries (62%), despite the fact that low-income countries bear a disproportionate share of the burden on morbidity and mortality from CCRWDs. Climate change is instituting new threats to communities who have had little past experience in planning for water-related disasters—lack of planning has led to a lack of mitigation efforts and increased impact from floods and other water events (Abaya et al., 2009).

The results of this analysis describe the cascade that is triggered by climate change, hydrologic and meterologic disasters, environmental disruption, and release of toxins that ultimately impact public health. CCRWDs endanger our health by affectively destroying or contaminating our food and water sources, the weather we experience, and our interactions with the built and natural environments. Disease risk increases as a result of climate change due to related expansions in vector numbers and ranges, shortening of pathogen incubation periods, and disruption and relocation of large human populations (Portier et al., 2010). As the climate continues to change, the risks to human health continue to grow (Crimmins et al., 2016). It is reasonable if not prudent to expect that CCRWDs will adversely impact the lives and health of a large percentage of the world's population over the next decades, thus the imperative for advancing evidence-based planning. Indeed, climate variability and change affect the most basic health requirements during nonemergency times: clean air, safe water, sufficient food, and adequate shelter. The increasing frequency and intensity of CCRWDs pose new challenges to the control of environmental toxic exposures and emerging infectious diseases, and gradually increase the pressure on the natural, economic, social, and health systems that sustain health.

Health impacts of CCRWDs may differ across populations and are dependent on several factors, such as existing vulnerability and adaptive capacity to changing meteorological conditions of these populations and the associated human and social consequences, as well as a myriad of other determinants that include the capacities, available resources, and existing behaviors and attitudes of these populations. Our findings suggest that more research is indicated to explore strategies for modifiable factors for reducing public health vulnerability, including exposure reduction, susceptibility reduction, and resilience building in disaster-impacted communities. Building the resilience of health systems to climate change is part of a preventive approach to public health. Existing shortfalls in providing basic health services determine that much of the global population is exposed to climate-sensitive health hazards. Additional investment is needed to strengthen key functions and to ensure that the health sector is ready to react to the challenges posed by climate change, including those posed by acute shocks such as natural disasters and disease epidemics, but also to long-term stresses.

Summary

Empirical evidence related to CCRWDs is predominately descriptive in nature, characterizing the cascade of climatic shifts leading to major environmental disruption and exposure to toxins, and their resultant morbidity and mortality. There is inadequate representation of research exploring potentially modifiable factors associated with CCRWDs and their impact on population health. This review lays the foundation for a wide array of further areas of analysis to explore the negative health impacts of CCRWDs and for nurses to take a leadership role in identifying and advocating for evidence-based policies to plan, prevent, or mitigate these effects.

Clinical Resources

- Centers for Disease Control and Prevention. Climate effects on health. https://www.cdc.gov/climateandhealth/effects/default.htm
- U.S. Department of Health & Human Services, Assistant Secretary for Preparedness and Response. Technical Resources, Assistance Center, and Information Exchange. https://asprtracie.hhs.gov
- U.S. Department of Health & Human Services, National Library of Medicine. Disaster Information Management Research Center. https://disaster.nlm.nih.gov/
- U.S. Environmental Protection Agency. Climate change and health. https://www.epa.gov/climate-impacts/climate-impacts-human-health%20%
- World Health Organization. Climate change and health. http://www.who.int/mediacentre/factsheets/fs266/en/

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

Figure S1. Articles by Country Income

Table S1. Type of Water Related Disaster Event

Table S2. Research Report Type, Purpose, Methods, and Sample Characteristics

Table S3. Key Findings in Studies of Climate Change Related Water Disasters Upon Public Health