INTRODUCTION

There is growing evidence and concern about the impacts of climate change on health and how to respond to these impacts. Because there is limited information about health risks associated with a variety of climate changes such as heat waves, droughts, wildfires, and flooding, nurses have an opportunity to inform others and limit adverse health impacts. Nurses are one of the most trusted health professionals.

WHAT IS CLIMATE CHANGE?

Climate change is a significant and lasting change in the distribution of weather patterns over periods of time ranging from decades to millions of years. It may be a change in average weather conditions, or in the distribution of weather around the average conditions (i.e., more extreme weather events).

The greenhouse effect is a process caused by greenhouse gases, which occur naturally in the atmosphere. This process plays a crucial role in warming the Earth’s surface, making it habitable. However, greenhouse gas emissions (generated by humans) disrupt the natural balance and lead to increased warmth. Greenhouse gases in the atmosphere prevent energy from immediately escaping from the Earth’s system. The greenhouse gases then distribute this energy, warming the Earth’s surface and lower atmosphere (See Figure 1)

CLIMATE CHANGE AND HEALTH

Human activities are causing environmental changes of epidemic proportions. The earth’s temperature is increasing, mainly as a result of human activity such as burning fossil fuel and greenhouse gas emissions. Emissions come from energy production, transportation, industry,
Unit VI: Climate Change

These changes are occurring globally at a rate that exceeds what the world has experienced over the last 650,000 years (Parry et al., 2007).

Climate change can be experienced as extreme weather events such as heat waves, melting of snow and ice with rising sea levels, changes in precipitation resulting in flooding and drought, more intense hurricanes and storms, wildfires, as well as poorer air quality. These changes highlight the critical need for us to consider the consequences of these environmental changes on health. Health impacts can result from direct exposures to climate change through changing weather patterns (e.g., heat waves), or indirectly through changes in water availability, air quality, and resultant changes in agriculture and the economy. Learn more by viewing the EPA video on Climate 101.

Regional climate changes are on the rise. In some locations, extreme precipitation events are becoming increasingly common such as the Northeast U.S., while in other areas droughts are more frequently experienced such as in the Southwest (Portier & Tart, 2010). The map from the Natural Resources Defense Council (NRDC) (see Figure 3) shows a range of extreme weather events in the US. Health impacts should be considered based on

Figure 2: [www.epa.gov/climatestudents/basics/concepts.html](http://www.epa.gov/climatestudents/basics/concepts.html)

Figure 3
these climate changes, which are regionally determined. These effects will continue to increase with climate changes.

HEAT-RELATED ILLNESSES

Average global temperatures are rising and are expected to continue to increase. The health impact of heat waves is an emerging environmental health concern. Health consequences of this global temperature rise include increasing rates of heat stress and exhaustion, heat cramps, heat stroke, and death. Heatwave events including the 2003 European event with 80,000 victims and the Russian event with approximately 54,000 fatalities have focused attention on the issue. With the anticipated increase in intensity and frequency of extremely hot weather events the impact on human health is expected to increase dramatically (Amengual, Homar, Brooks, Ramis, Gordaliza & Alonzo, 2014). Heat-related mortality in US cities is expected to more than double by the mid-to-late 21st century (Stone, Vargo, Habeeb, DeLucia, Trail, Hu & Russell, 2014). In the U.S., extreme heat events already cause more deaths annually than all other extreme weather events combined (Portier & Tart, 2010). Much of the excess mortality from heat waves is concentrated in infants, children, and those with chronic illnesses and those over 65 (Amengual, Homar, Brooks, Ramis, Gordaliza & Alonzo, 2014; Haines & Patz, 2004; Portier & Tart, 2010). Those living in urban environments are at added risk because of heat trapping materials used in the construction of roads and buildings.

Additionally, cities lack significant tree cover, exacerbating the high temperatures. Cities frequently experience ambient air temperatures from 1.8–5.4°F (1–3°C) warmer than the surrounding rural and suburban areas. This “urban heat island” also absorbs heat during the daytime and radiates it outward at night, raising nighttime minimum temperatures by 22°F (12°C) (Environmental Protection Agency (EPA), 2011a).

Learn more at: http://www.nrdc.org/health/climate/

WATER SECURITY AND DROUGHT

Water security, or the reliable availability of water for drinking, agriculture, manufacturing, and many other uses, is essential to human health. However, floods and droughts that result from climate change can dramatically impact water availability and surface water quality (Delpla et al., 2009). In Southern U.S. states, droughts have become a more frequent occurrence; Western states have experienced water shortages worsened by reduced mountain snowpack attributable to global warming (Portier & Tart, 2010).

Figures 5 & 6 provide information on drought and flood vulnerability in the U.S.

INSECT-BORNE DISEASES

Many major infectious disease agents (such as bacteria and viruses) and the vectors or organisms that carry them (e.g. mosquitoes) are highly sensitive to temperature and rainfall (Patz, Campbell-Lendrum, Holloway & Foley, 2005). There is potential for climate change to impact the range and incidence of vector borne and zoonotic diseases which are influenced by the ecology of insects and on the life cycles of the disease-causing germs they carry (www.cdc.gov/ncezid). As environmental conditions change, the geographic range of the vectors for illnesses is extended, increasing the potential for infection. For example, as temperature increases, the malaria parasite reproduces at a higher rate and mosquitoes feed more...
frequently. Changes in climate may make insect-borne diseases harder to control.

RESPIRATORY DISEASES AND PREMATURE DEATH

It is predicted that health impacts from climate change and ozone pollution in 2020 will result in significant increases in acute respiratory symptoms, asthma-related emergency room visits, weather-related hospital admissions for infants and the elderly, lost school days, and premature deaths (Costello et al., 2011). Small changes in temperature (a degree or two) coincide with increasing ground-level ozone and, with it, a significant effect on death rates. An estimated 3,700 deaths annually can be attributed to these small increases in ozone levels (Bell et al., 2004; Bell et al., 2008; Perera & Sanford, 2011).

Climate change and resulting air pollution poses a serious threat to respiratory health (Babin et al., 2007; Ebi et al., 2006; Ebi & McGregor, 2008; Parry et al., 2007). There is now strong evidence linking changes in the seasonal pattern of allergenic pollen and excess death from heat waves. Global warming has caused an earlier onset of the spring pollen season in the Northern Hemisphere (Metz et al., 2007) and increased the production of allergens (e.g., ragweed). Temperature increases and increased carbon dioxide (CO₂) concentrations produce earlier flower blooming, affecting the timing and distribution of allergens such as pollen. It is anticipated that respiratory allergies and asthma will become more common and severe because of increased exposure to pollen, molds, and air pollution as a result of climate change (D’Amato et al., 2010; Ebi et al., 2008). Figure 7 shows ozone and ragweed occurrence in the U.S.

MENTAL HEALTH

Climate change may affect mental health directly by exposing people to trauma (Berry, Bowen & Kjellstrom, 2010). Adverse psychiatric outcomes are well-documented in the aftermath of natural disasters (Page & Howard, 2010), and can include both acute traumatic stress and more chronic stress-related conditions (such as post traumatic stress disorder). Extreme heat events, which will become common as global temperatures rise, may be associated with a general increase in aggressive behavior, higher rates of criminal activity, and increased suicide rates (Berry et al., 2010). There will likely be an increase in the overall burden of mental disorders worldwide as extreme weather conditions and natural disasters can lead to displacement, loss, and social disruption. Those who are already vulnerable to stress-related disorders and mental health disease are at even higher risk following extreme weather conditions.

FOOD SECURITY

Climate change compromises agricultural production, especially in areas with limited capacity to adapt to these variations (Muller et al., 2011; Burke & Lobell, 2010). Climate change is predicted to worsen malnutrition in the developing world (Parry et al., 2007). Extreme weather events and changes in temperature and precipitation patterns can directly damage or destroy crops and other food supplies. This may happen seasonally, but is anticipated to become a chronic problem under changing climate conditions. (Portier & Tart, 2010). Modeling studies have shown that corn and soybean yields in the U.S. fell by 17% for every degree rise in growing season temperature (Lobel & Asner, 2003). It is predicted that by the end of
the 21st century one half of the world's population could face severe food shortages due to the impact of rising temperatures on staple food crops. In subtropical and tropical regions, staple food crops could fall by 20-40% (Battisti & Naylor, 2009).

**NATURAL DISASTERS AND CLIMATE CHANGE**

Extreme weather conditions result in disasters. It has become evident both nationally and globally, that climate change in the form of extreme weather events such as hurricanes, floods, heat waves, droughts, and tornados requires us to protect our communities through adaptation and preparedness measures. Many municipalities and states within the U.S. have outlined preparedness and/or adaptation plans to address disasters from extreme weather events. Georgetown Climate Center offers an Adaptation Clearinghouse with policy and adaptation toolkits to assist communities in preparing for extreme weather events.

With the increase in the intensity and frequency of natural disasters there is the threat to public health from fallout of energy sources such as nuclear power. One recent example is the nuclear crisis in the Japan crisis post-tsunami in 2011 (http://www.pbs.org/newshour/news/japan-disaster/; http://www.usgs.gov/newsroom/article.asp?ID=2727&from=rss_home).

The promotion of sources of energy such as solar and wind would avoid environmental concerns that are present with nuclear energy, as natural disasters increase in the number and severity with climate changes. A recent study found that wind turbines can actually reduce winds from hurricanes, providing in essence, a protective effect.

Additional benefits of energy sources such as solar and wind are that these are renewable. This means that energy is generated from natural resources that are naturally replenished. Nurses must advocate for clean energy policies that support safe, renewable sources of energy such as wind, solar, biomass, geothermal, hydro, tidal, and wave. A comprehensive State Energy and Analysis Tool that can provide a state-level overview of the energy sector and clean energy options can be found at: State Energy Analysis.

For more information about climate preparedness watch the TED Talk: “Let’s prepare for climate change” by Vicki Arroyo.

**POPULATIONS AT GREATEST RISK**

Populations considered most vulnerable to the adverse effects of climate change, lack the ability to cope with the consequences of climate change. Women and children, older adults, and the poor are typically more susceptible to illness and death associated with heat- and extreme weather events, as well as waterborne, vector-borne, and food-borne illnesses.

**Women and Children**

Women and children are particularly vulnerable to extreme weather events. For example, women and children represented 90% of all victims in the 1991 cyclone in Bangladesh (Homer, Hanna & McMichael, 2009). Climate change will increase the risk of infant and maternal mortality, birth complications, and poorer reproductive health, especially in the tropical, developing countries (Rylander, Odland & Sandanger, 2013).

**Pregnancy and Birth Outcomes**

While the study of the potential influences on pregnancy and prenatal complications related to climate change is an emerging area of research, there is already evidence suggesting the adverse impacts associated with extreme heat and air pollution. In a study of approximately 60,000 births in California increased temperatures were significantly associated with preterm birth for all mothers, regardless of maternal racial/ethnic group, maternal age, maternal education, or sex of the infant. An 8.6% increase in preterm delivery was associated with a 10°F increase in the weekly average temperature, with greater risks observed for younger mothers, Blacks, and Asians (Basu et al., 2010). Deschenes, Greenstone & Guryan (2009) found the effect of extreme heat during pregnancy to be most important in the second and third trimesters on US births. Subramanian (2007) found evidence of associations between climatic variables, such as increased humidity, and pre-eclampsia and eclampsia which can adversely impact both mother and the fetus. Evidence also supports a strong causal relationship between air pollution and respiratory deaths in the post-neonatal period (Radim et al., 2005). As temperatures continue to increase in some regions of the world, consideration of its impact on birth outcomes is critical (Anderko, Chalupka, & Anderko, 2012).

**Children**

Children spend more time than adults outdoors, breathe more rapidly than adults, and are still developing their respiratory structures. There is strong evidence of associations between respiratory disease and a wide range of environmental variables impacted by climate, such as heat waves. Additionally, children are less able to deal with heat and are more susceptible to dehydration. They are therefore, more vulnerable to heat-related disease and death and will suffer disproportionately as the Earth warms (Ebi & Paulson, 2007; Sheffield, & Landrigan, 2011).
Elderly

Advanced age is one of the most significant risk factors for heat-related death in the U.S. because older adults are less able to regulate extremes in temperatures (Physicians for Social Responsibility (PSR), n.d.). In addition, older adults often have pre-existing medical conditions, such as cardiac and respiratory illnesses, that are made worse by climate related-conditions (Balbus & Malina, 2009). Finally, older adults are also more likely to live alone, and have limited mobility, cognitive constraints, and reduced social contacts, all factors that further increase their vulnerability (Anderko & Chalupka, 2012; Anderko & Chalupka, 2013; Amengual, Homar, Brooks, Ramis, Gordaliza & Alonzo, 2014)).

Poor

Those living in poverty are also extremely vulnerable to many of the health effects of climate change. Existing illnesses and challenges in daily life are further complicated by disruptions in access to public services, displacement from homes and the need to migrate with limited transportation options, and increased stress as a result of extreme climate events (Anderko & Chalupka, 2012).

Table 1 summarizes information related to health effects and populations most affected by extreme weather events.

ADVOCACY: THE CLEAN AIR ACT AND CLIMATE

Clean air, with reductions in carbon pollution is essential for a healthier climate and public. The health, environmental, and economic impacts of air pollution are significant. Each day, air pollution causes lost days at work and school, as well as reduces agricultural crop and commercial forest yields by billions of dollars each year.

The original Clean Air Act of 1963 was passed and established funding for the study of and cleanup of air pollution. However, there was no comprehensive federal response until Congress passed a much stronger Clean Air Act of 1970. That same year Congress created the EPA and gave it the primary role in carrying out the law. In 1990, Congress revised and expanded the Clean Air Act, providing EPA broader authority to implement and enforce regulations reducing pollutant emissions.

By reducing air pollution, the Clean Air Act has led to significant improvements in human health and the environment in the United States.

Since 1970,

- The six commonly found air pollutants have decreased by more than 50 percent,

<table>
<thead>
<tr>
<th>Weather Event</th>
<th>Health Effects</th>
<th>Populations Most Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat waves</td>
<td>Heat Stress</td>
<td>Extremes of age, athletes, people with respiratory disease</td>
</tr>
<tr>
<td>Extreme weather events (rain, hurricane, tornado, flooding)</td>
<td>Injuries, drowning</td>
<td>Coastal, low-lying land dwellers, low socio-economic status (SES)</td>
</tr>
<tr>
<td>Droughts, floods, increased mean temperature</td>
<td>Vector, food, and water borne diseases</td>
<td>Multiple populations at risk</td>
</tr>
<tr>
<td>Sea-level rise</td>
<td>Injuries, drowning, water and soil salinization, ecosystem and economic disruption</td>
<td>Coastal, low SES</td>
</tr>
<tr>
<td>Drought, ecosystem migration</td>
<td>Food and water shortages, malnutrition</td>
<td>Low SES, elderly, children</td>
</tr>
<tr>
<td>Extreme weather events, drought</td>
<td>Mass population involvement, international conflict</td>
<td>General population</td>
</tr>
<tr>
<td>Increases in ground-level ozone, airborne allergens, and other pollutants</td>
<td>Respiratory disease exacerbations (COPD, asthma, allergic rhinitis, bronchitis)</td>
<td>Elderly, children, those with respiratory disease</td>
</tr>
<tr>
<td>Climate change generally; extreme events</td>
<td>Mental health</td>
<td>Young, displaced, agricultural sector, low SES</td>
</tr>
</tbody>
</table>

Table 1: Center for Disease Control: Weather Events, Health Effects, and Populations Most Affected


- Air toxics from large industrial sources, such as chemical plants, petroleum refineries, and paper mills have been reduced by nearly 70 percent,
Implementing steps to reduce Green House Gas (GHG) emissions is only part of the challenge of addressing climate change. Scientific evidence indicates that even if GHG emissions were to be stabilized at current levels, the earth is already committed to significant warming by the end of the century. Climate change preparedness projects must begin immediately, as we advocate for regulations to reduce GHG emissions (Knowlton, 2008). Nurses can play a vital role in local and regional climate adaptation strategies by preparing their communities to be resilient and best cope with the anticipated health impacts of climate change (Gould, 2011; McMichael et al., 2008). Georgetown Climate Center has an Adaptation Clearinghouse with information for local communities and a listing of adaptation plans for each state in the U.S.

Effective advocates influence public policy, laws, and budgets by using facts, their relationships, the media, and messaging to educate government officials and the public on the changes they want to bring for a healthier environment. Tips for advocating effectively include:

- Know the facts: To gain and maintain credibility, it is critical that you have all of the facts on both sides of any issue. Having this information will help you in conversations with government officials, the media, other advocates, and the general public.

- Use the facts: Any position you take should be grounded in the facts. It is often helpful to put your facts into one-pagers that you can distribute. Many organizations such as the American Lung Association provide talking points or letters that can guide you (See Appendix A).

- Have clear and concise message: Government officials, the press and the general public do not have time for long-winded conversations or documents—you need to get to your point quickly and concisely. And remember to watch out for the jargon and acronyms used in different fields—you want everyone to understand the issues you are raising.

- Nurture relationships and work collaboratively: Advocacy is a joint venture— you need to find your allies and work with them. Your chances of success are much greater when there are large numbers of organizations and people on your side. Whenever possible, be sure you and your allies have consistent data and the same messages.

- Engage the public: Use the media, social media, petitions, letters, e-mails and other grassroots...
strategies to engage as many people as you can. Remember numbers speak loudly to elected officials!

• Make your voice heard! Advocacy is not the place for being shy. Make sure you spread the word—through meetings with government officials, press conferences, letters, petitions, rallies, and phone calls. And don’t forget to talk about what you are advocating for at dinner parties and social events— you never know who can become a useful ally.

• Say thank you: Remember that everyone is busy and their time is valuable. Keep your meetings short and always say thank you afterwards. When your advocacy is a success, always thank everyone who helped you achieve your victory!

CONCLUSION

Nurses are trusted by society worldwide. They must advise and advocate for a cleaner environment that mitigates climate changes through strong clean air and energy policies. Also nurses must help to prepare communities to adapt to extreme weather events resulting from climate changes.

APPENDIX A - CLIMATE CHANGE RESOURCES

Interviews:
• Dr. George Lakoff- climate change - NPR interview - talks about framing with linguistics.
• Smog Deaths in 1948 led to Clean Air Laws - NPR Interview

Webinars/Videos:
• 350.org
• American Public Health Association
• Climate Adaptation Mitigation and E-Learning
• Climate change and health webinar sponsored by Health Care Without Harm and the Alliance of Nurses for Healthy Environments:
• Climate Reality Project
• National Climate Assessment Webinars

Websites:
• Addressing climate change in the health care setting
• Anesthetic gases and carbon footprint
• Population Connection
• Climate 911 -- Dr. Wendy Ring's U.S. Bike Tour

• Climate Change Action Info
• Climate Communication
• Environmental Protection Agency's Carbon Footprint Calculator
• EnvıRN - The Alliance of Nurses for Healthy Environments (ANHE)
• Green Guide for Healthcare
• Health Care Without Harm
• Intergovernmental Panel on Climate Change
• Physicians for Social Responsibility
• Practice Green Health
• League of Conservation Voters
• Reducing Carbon Emissions: State and Company Successes
• US Climate Action Network (USCAN)
• USCAN Member Action Centers
• USCAN Climate Risks and Preparedness
• USA Today: Weathering Change – information about allergies and climate change

REFERENCES


Unit VI: Climate Change


Rylander, C., Odland, J. O & Sandanger, T. M. (2013) Climate change and the potential effects on maternal and pregnancy outcomes: an assessment of the most vulnerable the mother, fetus, and newborn child, Global Health Action, 6: 19538 http://dx.doi.org/10.3402/gha.v6i0.19538


