

Field report

Issues in the post-disaster food environment during the immediate response to Hurricane Florence

Post-disaster
food
environment

379

Lauren A. Clay

*Department of Health Services Administration,
D'Youville College, Buffalo, New York, USA and
Disaster Research Center, University of Delaware, Newark, Delaware, USA*

Received 7 December 2018
Revised 30 July 2019
30 July 2019
Accepted 30 July 2019

Abstract

Purpose – The purpose of this study was to explore issues related to the food environment from a systems perspective using a quick response disaster research methodology in New Bern, North Carolina during the immediate response to Hurricane Florence in 2018.

Design/methodology/approach – A four person reconnaissance team arrived six days after Hurricane Florence made landfall to observe community food and meal provision, interview individuals working in food related response, assess the price, quality and availability of food, and interview individuals affected by the storm during the immediate response period to Hurricane Florence in New Bern, North Carolina.

Findings – Multiple issues emerged that are important for the understanding of food in a disaster recovery context including food access issues for households with flooding damage as well as those with minor impacts like electricity loss or evacuation without damage, disruption to farming and retail food business, and changes in food availability.

Practical implications – When examining food access and food security, many community members were affected that did not experience housing disruption and there were shifts in community food availability after Hurricane Florence. Understanding these disruptions is critical for evaluating food-related response and assistance following disaster to ensure unmet needs are addressed. Further, addressing community food needs is an important lever for bolstering disaster recovery.

Originality/value – This is the first study in the USA to examine the food system following disruption from an environmental disaster and to identify issues in the post-disaster food environment.

Keywords Food security, Food system, Hurricane, Disaster response

Paper type Research paper

Introduction

On Friday 14 September 2018, Hurricane Florence made landfall in Wrightsville Beach, North Carolina as a category 1 storm with maximum wind gusts of 90 miles per hour and weakened as it slowly moved inland. Flooding from rain and storm surge was the primary concern in this event (Andone, 2018; Grubb and Bonner, 2018). The storm created record setting storm surge of 9–13 feet and 20–30 inches of rainfall. The areas most affected included “New Bern, Newport, Belhaven, Oriental, North Topsail Beach, and Jacksonville” and Kinston (National Weather Service, n.d.). In New Bern, 98 percent of residents lost power and early damage estimates indicate over \$1bn in damage to homes and businesses (North Carolina Department of Public Safety, 2018).

New Bern and the Neuse River

New Bern, is located in Craven County, North Carolina. It was established in 1710 at the mouth of the Neuse River (DataUSA, n.d.; US Census Bureau, 2017). The Neuse River winds for 250 miles from Raleigh, down through New Bern, and toward Pamlico Sound and the Atlantic Ocean. As it moves toward to the coast, it becomes a slower moving estuary habitat that is home to birds, dolphins, alligators, manatees, and sharks as well as many endangered species, including the piping plover and loggerhead turtle, and essential species, such as



blue crabs and oysters (American Rivers, 2017). It also provides recreational space including National Forests, State Parks, and game lands covering 216,000 acres (see Figure 1). The Neuse River feeds into the Falls Lake Reservoir, Raleigh's primary water supply. The Falls Lake Reservoir has led to issues with flood management as it separates the Neuse River from its floodplain, reduces water quality, and negatively influences the ability of the river to recover from disruptions from drought and floods (American Rivers, 2017).

New Bern is home to approximately 30,000 individuals. There are 12,631 households with a median income of \$41,970. The poverty rate is 19.1 percent with a homeownership rate of 51 percent, below the 64.4 percent rate nationally. New Bern residents are 54 percent white, 31 percent black and 6 percent Hispanic. The vast majority of residents are native English speakers and US citizens (DataUSA, n.d.; US Census Bureau, 2017).

Exposure to Hurricane Florence in New Bern, NC

In the early hours of Friday 14 September 2018, the National Hurricane Center reported 7 inches of rain and 10 feet of flooding inundation in New Bern (Grubb, Bonner, 2018; Andone, 2018). Almost all New Bern residents were without power by Friday afternoon (Mayo, 2018). Craven County has five swift water rescue teams and the Cajun Navy, a volunteer group from Louisiana, were also in the area assisting (Grubb and Bonner, 2018) with approximately 200 calls for help by Friday evening as the rain continued to inundate the area (Andone, 2018; Grubb and Bonner, 2018; Bennett, 2018). On 15 September, the North Carolina National Guard and Greenville Fire Department swift water teams conducted door-to-door welfare checks in parts of New Bern (Bennett, 2018).

Early reports indicate that 4,325 homes and 300 businesses were damaged in New Bern totaling \$74.5m in residential losses and \$25.6m in commercial losses; however, the extent of the damage was still being assessed at the time of writing (Bennett, 2018; US Census Bureau, 2017). Many households in the area were still recovering from damage from Hurricane



Figure 1. Map of Eastern North Carolina, rivers, parks and cities

Matthew in 2016 when Hurricane Florence arrived (Andone, 2018; National Weather Service, 2017). According to the North Carolina Department of Public Safety, as of 24 October 2018, \$258m National Flood Insurance Program claims had been paid, \$105m in state grant funds for homeowners and renters, and \$219m in Small Business Association loans were approved for individuals affected by Hurricane Florence (North Carolina Department of Public Safety, 2018). Impacts from disasters like Hurricane Florence are especially challenging for families with limited resources.

Food security and the post-disaster food environment

Food insecurity is a household constraint that is a manifestation of social, economic and political forces in society, within institutions, and throughout the community and environment (Sallis *et al.*, 2008; Blaikie *et al.*, 1994; Obrist *et al.*, 2010). It lies at the intersection of multiple systems on the household and community level, including those related to supply chains, environmental health, economies, agriculture and social programs. In turn, it is a critical lever for improving health, well-being and quality of life for families.

In the USA in 2017, 11.8 percent of the population experienced food insecurity (USDA Economic Research Service, 2018). Food insecurity is defined by the United States Department of Agriculture (USDA) (2017) in two categories: “low food security” and “very low food security.” Low food security is defined as “reports of reduced quality, variety, or desirability of diet. Little or no indication of reduced food intake.” Very low food security is defined as, “reports of multiple indications of disrupted eating patterns and reduced food intake.” Food insecurity in North Carolina is 8th highest in the USA with an average of 15.9 percent of the population experiencing food insecurity over the years 2013–2015 and one in five children struggles with getting enough food to eat (Budget and Tax Center, 2016; Feeding America, 2018). In Craven County, 17,230 individuals (16.5 percent of the population) experienced food insecurity in 2016–2017. Of those individuals, 5,600 (32.5 percent) were children under age 18 (Food Bank of Central and Eastern North Carolina, n.d.).

Little research has been conducted on the food environment in a post-disaster setting in the US. A peer review literature search of WorldCat, General OneFile and Academic OneFile for the terms “disaster” AND “food” AND “US” returns 2,271 articles in English. Of the 100 most relevant abstracts, only 4 articles focus on food or agriculture in a US disaster context, however none focused on meeting community food needs during disaster (Law, 2006; Liu, Wein, 2008; McGuire, 2006; Nelson *et al.*, 2016). A Google Scholar search for the same terms finds additional studies focused on emergency food as one aspect of preparedness or response activities (Tierney *et al.*, 2001), social vulnerability to disaster including food as one component (Fothergill *et al.*, 1999; Fothergill and Peek, 2004), the impact of climate change on food supplies and agriculture (Cutter, 2017), or food related outbreaks (Balbus and Malina, 2009; Greenough *et al.*, 2001). As these searches demonstrate, there are no comprehensive studies of the food environment following disaster. This study explores issues related to the food environment from a systems perspective using a quick response disaster research methodology in New Bern, North Carolina during the immediate response to Hurricane Florence in 2018.

Field research and data collection methodology

Quick response disaster research, conducted by a reconnaissance team aims to arrive in the disaster affected area as quickly as possible, while the event is still unfolding, to gain access to, observe, and conduct informal interviews with individuals active in response activities during the peak of activity. The timing of arrival and observation enables the research team to determine the *Gestalt*, or the greater whole composed of many parts, of a disaster event and identify organizations and opportunities for follow up study that are important for the specific event (Stallings, 2007). In the present study, the reconnaissance team arrived

five days after Hurricane Florence made landfall, as the event was still unfolding. The goals of the research were to: observe community food and meal provision; interview individual working in food related response; assess the price, quality and availability of food and interview individuals affected by the storm during the immediate response period to Hurricane Florence in New Bern, North Carolina.

Guided by the NOURISH food system model, this study conceptualizes the food environment as a complex adaptive system, comprised of a set of diverse, autonomous actors whose work is interdependent and connected to ensure community food needs are met. Small changes or “tipping” in one area can lead to destabilization or disturbance across the system (Neff, 2014). As shown in Figure 2, the NOURISH model focuses on the social sector including health and social systems, the economic sector including political and economic systems, the environment sector including biological systems, and the farming sector including all inputs into the food chain. At the center of the model is the food supply and human experience with food including food literacy, food intake and waste production (WorldLink, n.d.). Of particular importance to this study, the local food system is conceptualized, according to the NOURISH model, as growing, harvesting, packaging, transporting, retailing, eating and disposing of food (WorldLink, n.d.). As shown in Figure 3, the local food system involves farmers, farm workers, transportation workers, retailers and food providers, and consumers. The linkages between actors are vulnerable to disruption by a disaster event at multiple points, for example: growing and harvesting may be negatively impacted by flood or drought; transport may be interrupted when infrastructure is damaged; and the sale and consumption of food may fluctuate with unusual patterns in supply and demand.

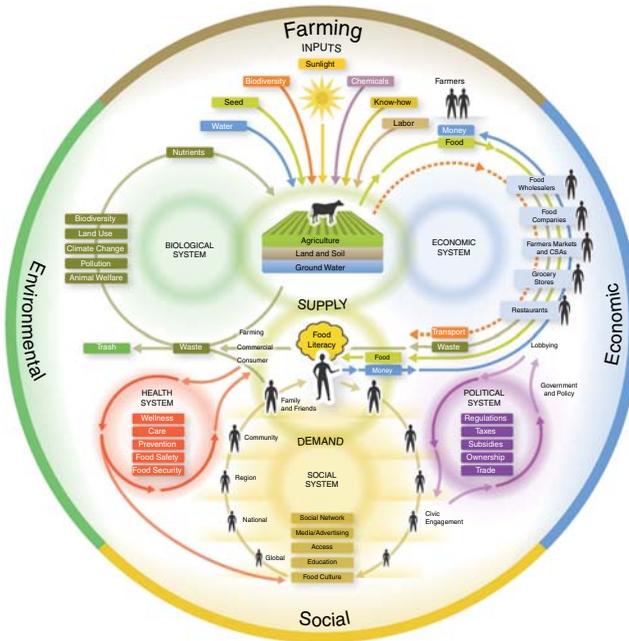


Figure 2.
NOURISH food
system map

Source: www.nourishlife.org. Copyright 2012 WorldLink, all rights reserved

LOCAL FOOD SYSTEM



Source: www.nourishlife.org. Copyright 2012 WorldLink, all rights reserved

Figure 3.
NOURISH food
system diagram

To operationalize data collection for this complex adaptive system, the NOURISH food system and local food system models were used to guide the development of data collection protocols to capture information from farmer to consumer. Observations and assessments were conducted on growing and harvesting by interviewing farmers, retailing by observing retail food stores and community food and meal distribution sites as well as interviewing representatives at these sites, and eating by talking with individuals affected by Hurricane Florence about their experience with food and meals. From 19–24 September 2018, a four-member research team spoke with 24 individuals affected by the storm and 12 organizational representatives participating in food system related response. Additionally, we assessed ten food or meal distribution sites and ten food stores. Interviewees were asked about their experience with the storm, property impacts, challenges and unmet needs. In this field report, observations of issues in the immediate response period to Hurricane Florence are reported and discussed.

Institutional review board approval was obtained from D'Youville College prior to beginning field work. The field team was housed in Raleigh, North Carolina to minimize additional burden on the disaster affected communities. Each day the field team traveled more than 2.5 hours to the New Bern area carrying food and water for the day. Supplies for overnight stay in the van were carried each day to ensure team self-sufficiency during field work. When appropriate, the field team purchased food at local food establishments to support local businesses.

Emerging issues in the food environment during the immediate response period

Emerging issues in the immediate response to Hurricane Florence are presented in the framework of the local food system, including: growing and harvesting, transportation, retailing or community food provision and eating.

Growing and harvesting

Before the storm, farmers worked as fast as possible to harvest crops that could be harvested; it was described as a race against time. Once the water started rising, it shifted to a waiting game, waiting for the water to recede and waiting for notification about whether the crops that were salvageable could be put into the food chain. One farmer we spoke with lost 75 percent of his crops, including wheat, soybeans and corn. As the storm was approaching, he worked around the clock to harvest as much corn as possible before the rain started. He was only able to harvest about half of the crop and was in a waiting period to hear from the local FSA newsletter about whether it was safe to put the crops that were left in the field into the food chain.

In addition to agriculture for food, there was a concern about the lost grain in the region resulting in not enough grain to feed the livestock. Without enough local grain, supplies would have to be brought in from outside growers to meet the needs of livestock operations. This not only affects the livestock industry but also would significantly affect the livelihoods of many local farmers.

Transport

While we did not interview any food transportation workers directly, we spoke with a local tractor supply store worker about the impact of the storm on farming equipment and the transportation challenges related to the movement of goods via trucking. Claims were starting to come in for lost equipment during the week immediately following the storm. He described the issue of rust and how often it was more cost effective to replace the equipment than the many parts damaged by salt water. He also described difficulty with getting supplies into the area pre-event. They ordered chain saws and generators to have in stock pre-event but the supply did not reach them due to restrictions on trucking in counties with federal disaster declarations. To meet consumer needs, store workers drove an 18-wheeler from inside the disaster declared county to the county line and unloaded and reloaded all the supplies onto the local truck that could be hauled into New Bern. Similar supply chain disruptions likely impact the movement of food across county lines where there are federal disaster declarations as well.

Retailing and community food provision

There were many local food sources available to New Bern residents following Hurricane Florence, including grocery stores, distribution sites of non-perishable foods and hot meal provision across the city.

Food stores. Food stock in grocery stores varied across stores and within stores by department. We observed ten food stores in New Bern from large corporate owned stores to corner convenience stores. A locally owned grocery store was the most well-stocked of the stores we assessed. Speaking with the managers in produce and dairy, we learned that they source from four local farms. They had not experienced any disruption to electricity and supplies during Hurricane Florence; however, there were some quality changes noted by the produce manager. Larger corporate owned stores had much more varied stock. In comparison to smaller, grocery-only stores, the larger stores that carry household goods and groceries, were observed to be heavily trafficked and to have greater variability in food availability. We hypothesize that households needing to purchase a range of items, in addition to groceries, were shopping at the one-stop shopping locations rather than specialized stores for different types of goods. One large chain grocery store was out of bread, had low stock of milk, bananas, and organic produce, and was completely out of packaged salads, many varieties of lettuce and tomatoes.

Across all stores and meal distribution sites, bread was scarce. There were rumors about a bread storage facility flooding; however, we were not able to confirm this information or

confirm the location of the facility during our field work operation. We did observe at numerous stores that the bread section was sparse or completely empty. At one chain store, a stocker described filling the shelves then taking his break and when he returned, it was already all sold out. We only observed white bread stock in many stores as well.

Grocery store managers also described shifts in clients and changes in purchasing behavior immediately following Hurricane Florence. They were seeing many new clients, and quantities being purchased were much larger than they had ever experienced. There was a recognition that some stores were still closed in neighboring communities, so people were shopping in stores they do not usually frequent. Staff interviewed also speculated that people were shopping further away from home and buying larger quantities to avoid multiple shopping trips. One example provided was a new client shopping in the store and requesting a two-gallon half-and-half. It was also thought that customers may be feeding more people if they were housing displaced family or friends. The changes in purchasing behavior created challenges for stocking the shelves to meet immediate consumer needs and also raised concerns about adjusting stock when demand is uncertain into the future and could lead to issues of overstock and spoilage.

Community meal and food distribution. Food and meals were being distributed in a variety of methods from non-perishable food boxes to one-off hot meal distribution at events, to regular hot meals distributed in mass feeding and door-to-door operations. Community organizations and institutions such as schools and churches mobilized door-to-door meal distribution operations. We spent one evening observing the meal distribution operation of a local elementary school that was started by the school principal when she saw the families of her students posting on social media that they needed food. The school principal connected with the American Red Cross (ARC) and was having hot meals delivered at lunch and dinner daily. Volunteers worked in the elementary school cafeteria, without electricity, to assemble 150 meals, and then loaded the meals into a caravan of cars for neighborhood distribution. They offered a hot meal and cold water, which was at a premium due to ice shortages, to anyone that was in their yard. The volunteers explained that many people lost vehicles in the storm and were not as mobile to get food and they were busy mucking out their homes. There was no selection process for providing meals that we observed, anyone that wanted a meal could have one. Children were often the residents to claim the meals, sometimes chasing after the caravan to collect meals for their family. During the meal distribution, teachers also had the chance to check in with students and friends in the community. The school principal reported that half of their students were made homeless by the storm and many families were already struggling before the storm. The ARC was providing three types of meal service in New Bern and the surrounding communities: stationary service in neighborhoods from their Emergency Response Vehicles, “seek and serve” where they drive through neighborhoods to distribute hot meals, and drop off where an organization assembles and distributes the meals provided by the ARC.

Non-perishable food distribution was also common. An effort run by a local church in New Bern had established an outreach operation that relied on donations and collection among the congregation to assemble needed supplies including food, personal hygiene and cleaning supplies for distribution. They sent teams into the community to talk with families and determine household needs. This information was communicated back to the church immediately by phone. By the time the team returned from the field, the needed supplies and resources had been gathered and were loaded up immediately for the field team to distribute. This operation was meeting community needs in near real time.

Event based meal provision was also observed. One church, located in a low-income neighborhood, held an event where a local food truck served hot meals and they were

accepting, sorting, and distributing donations while music played over a sound system to foster socializing. On Saturday 22 September, several community organizations organized to put on a benefit concert hosted at a local social club that was on the border between lower and higher income communities in New Bern to bring the community together. At this event there was live music, food trucks, and grilled steaks and sides prepared and donated from local restaurant partners.

Additional religious organizations were starting mobile kitchens throughout our field operations. One church had a crew and mobile kitchen arrived on Sunday 23 September and was beginning meal distribution. Many additional community organizations were providing non-perishable foods. One religious organization in the community, in coordination with their national offices had disaster supply boxes available. They had infant care, personal care, and family food boxes with food for four people for four days available at the time of our visit.

Mass feeding. The primary mass feeding operation in New Bern was run by the North Carolina Baptist Men's Organization. They had one large kitchen operating on the grounds of Temple Baptist Church where they supplied the ARC with hot food for their meal distribution operations and ran a mass feeding drive-thru for lunch and dinner each day, as well as breakfast for volunteers. One volunteer reported that they were cooking up to 16,000 meals per day during the first week. The kitchen can produce up to 25,000 meals when running at full capacity. One limitation of the operation was that you had to have a car to access meals in the drive-thru. In addition to meals in the drive-thru line, there was a resource center set up inside the church where community members could access information about disaster assistance.

Eating

Meal distribution in the community was essential for many families that lacked access to transportation or that were working long hours to clean up damaged homes or property and not taking the time to stop for meals. On Friday afternoon, we met one family that had just returned home that morning to a home that had been heavily flooded. They had nine family members working to remove all the furniture and belongings from the house. They were moving so quickly that they hardly noticed when community members arrived with hot meals in their yard to offer them something to eat. At first they declined, then one woman stopped and said "yes" to a bottle of cold water and had a moment to think and realized that they had not eaten anything all day; she took nine meals for the family to eat. People not taking the time to eat because there was so much to do was something we heard again and again, and not just from people with damaged homes.

Volunteers from within the community described not taking the time to eat or not eating well because they were overwhelmed by the work and community need. We observed or heard stories from volunteers that went the whole day without meals or snacks because they either gave it all away to people in need or they just did not think to stop and eat. One volunteer talked about not having an appetite or getting to the end of the day and realizing she had not eaten anything. She indicated she was often too tired to prepare something or ate something fast and easy like ramen noodles so she could get to sleep.

Among resource-constrained households, the storm affected the ability of families to purchase food to meet household needs when the household either lost electricity or had to evacuate. One older woman who experienced electricity loss described losing all of her perishable food and waiting to find out about whether her Supplemental Nutrition Assistance Program (SNAP) benefits would be reissued. She explained that she did not have any damage, so she did not want to take meals that might deprive others who were affected; but she did not have many people to turn to for help, so she was just waiting and hungry.

Another community member, a father of seven, spent all of the family's financial resources evacuating with his children. He described that community meals were helping his family get by since they lost electricity and had to dispose of all the food spoiled during the storm and lacked resources to purchase more.

Implications

This study is the first to explore the issues of food access and availability in the immediate response phase in a US context. Multiple issues emerged that are important for our understanding of food in a disaster recovery context. An important issue identified in the immediate response period in New Bern following Hurricane Florence was that it was not only individuals with significant property damage that were struggling with meeting their food needs after exposure to the disaster, but those with minor disruptions such as electricity loss or depleted resources due to evacuation costs as well. Additional research on those individuals with limited financial resources before disaster exposure is needed. A careful evaluation of disaster related program eligibility and affected populations is essential to identify potential gaps.

Serving meals was observed as an opportunity to bring the community together to share a meal, but also share resources and information, distribute supplies and provide social support. This was demonstrated through outreach operations, community events, and meal distribution sites. Community feeding may be an opportunity to better meet food needs and also to provide a range of additional services and supports. Interventions fostering community feeding and more comprehensive services extending from immediate response through longer-term recovery may be an important lever to bolster community recovery. Regular community meals, in non-disaster times could also provide an opportunity for community members to build networks and bolster resilience to disasters in the absence of an event.

Finally, investigation of the human health consequences of disruption to the food system is needed to understand how nutrition and the health of families is impacted when there is a disruption such as loss of electricity, housing loss including kitchen facilities, displacement in different settings and changes to the local food supply. We observed that meals and food provision was an issue for those with housing loss as well as those that may appear to have fared well from a flooding damage perspective. Additional data collection is planned in New Bern, North Carolina to collect data through early and longer-term recovery to study how food access, availability, and quality changes over the disaster cycle for individuals and to capture a broader range of experiences from across the food system including farmers, individuals working in packaging and transportation of food, and different retail food providers. A survey of all disaster affected counties in North Carolina is also in development to investigate what features of the post-disaster food environment are specific to the New Bern area and what may be more generalizable across communities and thus important levers for bolstering community response to food needs in a disaster context.

References

- American Rivers (2017), "Neuse River: North Carolina", available at: www.americanrivers.org/river/neuse-river/ (accessed October 31, 2018).
- Andone, D. (2018), " 'Storm of a Lifetime' How Hurricane Florence Battered the Carolinas, day by day".
- Balbus, J.M. and Malina, C. (2009), "Identifying vulnerable subpopulations for climate change health effects in the United States", *Journal of Occupational and Environmental Medicine*, Vol. 51 No. 1, pp. 33-37.

- Bennett, A. (2018), "New Bern is counting up the damage from Hurricane Florence. It's at \$100 million so far", *The News and Observer*, September 23, available at: www.newsobserver.com/news/local/article218889660.html (accessed October 31, 2018).
- Blaikie, P., Cannon, T., Davis, I. and Wisner, B. (1994), *At Risk: Natural Hazards, People's Vulnerability, and Disasters*, Psychology Press, London.
- Budget and Tax Center (2016), *Hunger in the Tar Heel State*, North Carolina Justice Center, Raleigh, NC.
- Cutter, S.L. (2017), "The perilous nature of food supplies: natural hazards, social vulnerability, and disaster resilience", *Environment: Science and Policy for Sustainable Development*, Vol. 59 No. 1, pp. 4-15.
- DataUSA (n.d.), "New Bern, North Carolina", available at: <https://datausa.io/profile/geo/new-bern-nc/> (accessed September 20, 2018).
- Feeding America (2018), "Hunger in North Carolina", available at: www.feedingamerica.org/hunger-in-america/north-carolina (accessed October 31, 2018).
- Food Bank of Central and Eastern North Carolina (n.d.), *2016-2017 Craven County Profile*, Food Bank of Central and Eastern North Carolina, available at: www.foodbankcenc.org/site/DocServer/Craven.pdf?docID=3765 (accessed November 4, 2019).
- Fothergill, A. and Peek, L.A. (2004), "Poverty and disasters in the United States: a review of recent sociological findings", *Natural Hazards*, Vol. 32 No. 1, pp. 89-110.
- Fothergill, A., Maestas, E.G. and Darlington, J.D. (1999), "Race, ethnicity and disasters in the United States: a review of the literature", *Disasters*, Vol. 23 No. 2, pp. 156-173.
- Greenough, G., McGeehin, M., Bernard, S.M., Trtanj, J., Riad, J. and Engelberg, D. (2001), "The potential impacts of climate variability and change on health impacts of extreme weather events in the United States", *Environmental Health Perspectives*, Vol. 109 No. S2, pp. 191-198.
- Grubb, T. and Bonner, L. (2018), "As the water rises, hundreds rescued from New Bern and Beaufort County", *The Herald Sun*, September 14, available at: www.heraldsun.com/news/local/article218380955.html (accessed October 20, 2019).
- Law, J. (2006), "Disaster in agriculture: or foot and mouth mobilities", *Environment and Planning A*, Vol. 38 No. 2, pp. 227-239.
- Liu, Y. and Wein, L. (2008), "Mathematically assessing the consequences of food terrorism scenarios", *Journal of Food Science*, Vol. 73 No. 7, pp. M346-M353.
- McGuire, T. (2006), "Louisiana's Oysters, America's Wetlands, and the Storms of 2005", *American Anthropologist*, Vol. 108 No. 4, pp. 692-705.
- Mayo, N. (2018), "Hurricane Florence: New Bern still needs rescues; Outer Banks surveys damage", *The Greenville News*, September 14, available at: www.greenvilleonline.com/story/news/2018/09/14/hurricane-florence-outer-banks-damage-new-bern-rescue-power-outages-closures/1301386002/ (accessed November 2, 2018).
- National Weather Service (n.d.), "Historical Hurricane Florence", available at: www.weather.gov/mhx/Florence2018 (accessed September 12-15, 2018).
- National Weather Service (2017), "Hurricane Matthew in the Carolinas: October 8, 2016", available at: www.weather.gov/ilm/Matthew (accessed October 31, 2018).
- Neff, R. (2014), *Introduction to the US Food System: Public Health, Environment, and Equity*, John Wiley & Sons, San Francisco, CA.
- Nelson, M.C., Ingram, S.E., Dugmore, A.J., Streeter, R., Peoples, M.A., McGovern, T.H., Hegmon, M., Arneborg, J., Kintigh, K.W., Brewington, S., Spielmann, K.A., Simpson, I.A., Strawhacker, C., Comeau, L.E., Torvinen, A., Madsen, C.K., Hambrecht, G. and Smiarowski, K. (2016), "Climate challenges, vulnerabilities, and food security", *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 113 No. 2, pp. 298-303.
- North Carolina Department of Public Safety (2018), "Hurricane Florence 2018", available at: www.ncdps.gov/florence (accessed November 4, 2018).

-
- Obrist, B., Pfeiffer, C. and Henley, R. (2010), "Multi-layered social resilience: a new approach in mitigation research", *Progress in Development Studies*, Vol. 10 No. 4, pp. 283-293.
- Sallis, J., Owen, N. and Fisher, E. (2008), "Ecological models of health behavior", in Glanz, K., Rimer, B. and Viswanath, K. (Eds), *Health Behavior and Health Education*, Jossey-Bass San Francisco, CA, pp. 465-486.
- Stallings and R.A. (2007), "Methodological issues", in Rodriguez, H., Quarantelli, E.L. and Dynes, R.R. (Eds), *Handbook of Disaster Research*, Springer, New York, NY, pp. 55-82.
- Tierney, K.J., Lindell, M. and Perry, R. (2001), *Facing the Unexpected: Disaster Preparedness and Response in the United States*, Joseph Henry Press, Washington, DC.
- United States Department of Agriculture (2017), "Definitions of food insecurity", available at: www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/definitions-of-food-security/ (accessed November 12, 2018).
- US Census Bureau (2017), "Quick Facts New Bern City, North Carolina", available at: www.census.gov/quickfacts/newberncitynorthcarolina (accessed November 12, 2018).
- USDA Economic Research Service (2018), "Food Security in the U.S. Key Statistics and Graphics", available at: www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics.aspx (accessed October 31, 2018).
- WorldLink (n.d.), "Food system tools", available at: www.nourishlife.org/teach/food-system-tools/ (accessed July 14, 2018).

Corresponding author

Lauren A. Clay can be contacted at: clayl@dyc.edu