Evaluation and Program Planning 46 (2014) 80–86

Contents lists available at ScienceDirect

Evaluation and Program Planning

journal homepage: www.elsevier.com/locate/evalprogplan

Understanding the economic impacts of disruptions in water service☆

Colleen Heflin [a,*], Jennifer Jensen [b], Kathleen Miller [c]

[a] Truman School of Public Affairs, University of Missouri, United States
[b] Cornell University, United States
[c] Rural Policy Research Institute, Truman School of Public Affairs, University of Missouri, United States

ARTICLE INFO

Article history:
Received 26 July 2013
Received in revised form 7 May 2014
Accepted 14 May 2014
Available online 2 June 2014

Keywords:
Resilience
Utility

ABSTRACT

Over the past decade, there has been much attention focused on community readiness for catastrophic emergency events, such as major natural disasters or terrorist attacks. However, though the economic costs associated with experiencing such an event are high, the probability of such events occurring is quite low. At the same time, less catastrophic events that temporarily disrupt essential services to local areas, such as water and electricity, are quite common. However, there is little research that documents residents' actual economic costs when their water service is disrupted. In this paper, we contribute to the growing literature assigning economic value to residential water service by documenting the economic costs residents report from routine, small-scale water disruptions through focus groups and in-person interviews. We find that residential impacts ranged from over $1400 in savings (from working more hours than usual and eating out less than usual) to a cost of over $1000, with an overall average of $93.96. These costs, particularly when multiplied over a substantial population, become quite significant and demonstrate the importance of studying the economic costs of such events.

1. Introduction

Over the past decade, there has been much attention focused on community readiness for catastrophic emergency events, such as major natural disasters or terrorist attacks. However, though the economic costs associated with experiencing such an event are high, the probability of such events occurring is quite low. At the same time, less catastrophic events that temporarily disrupt essential services to local areas, such as water and electricity, are quite common. For example, the American Society for Civil Engineers reports there are over 240,000 water main breaks in the United States every year (2013). Corrosion is the major cause of water main breaks, and over eight percent of installed water mains in the United States and Canada are beyond their useful life (Environmental Protection Agency, 2002; Folkman, 2012). The American Water Works Association estimates that the water main system needs an investment of over $1 trillion in the coming twenty-five years (2013). As infrastructure continues to age, and local jurisdictions face tight budget constraints, water disruptions are likely to increase in frequency. There are economic models, imposing various assumptions, that estimate the economic value of water lost to residents (Aubuchon & Morley, 2013; FEMA, 2009). However, there is little research that documents residents' *actual* economic costs when their water service is disrupted. In this paper, we contribute to the growing literature assigning economic value to residential water service by documenting the economic costs residents report from routine, small-scale water disruptions.

Despite the frequency of temporary and localized water disruption events, there is surprisingly little empirical data compiled on the economic costs for residents. For a total water outage, FEMA (2010) provides a per capita per day total economic cost of $97 (in 2011 dollars) to both businesses and residents. This cost assumes constant water consumption rate of 172 gallons and a price elasticity of −0.41, and is used to help FEMA plan for hazard mitigation. Improving on this general method, Aubuchon and Morley (2013) add geographic variation in total water consumption, as well as different price elasticities. This research produces a range of costs, $23–$2138 per capita per day (in 2011 dollars) for residential economic costs alone, but settles on a preferred estimate $153 per capita per day. While useful, these models all

☆ Funding for this research was provided by the U.S. Department of Homeland Security, Science & Technology Directorate, through a technology development and deployment program managed by The National Institute for Hometown Security, under Other Transactions Agreement (OTA) #HSHQDC-07-3-00005.

* Corresponding author. Tel.: +1 5738824398; fax: +1 5738844872.
E-mail addresses: heflincm@missouri.edu (C. Heflin), Jensen@rupri.org (J. Jensen), miller@rupri.org (K. Miller).

http://dx.doi.org/10.1016/j.evalprogplan.2014.05.003
0149-7189/

assume a daily, basic water requirement of 6.6 gallons at a price of $1.85 per gallon. These estimates do not report actual water used during an outage, or the actual costs experienced. Also, the existing models only include costs associated with replacing water. But certainly, other costs occur. In a water outage, residents absorb costs associated with the time loss of bleaching or boiling water, the substitution costs associated with changing cooking and eating behavior, travel costs, and changed work and school schedules.

Survey based estimates documenting the costs associated with water contamination events usually include a broader set of economic costs, such as health care costs and productivity losses. But, these estimates tend to ignore the household costs of the water outage. For example, Halonen (2012) documents the cost to employers in lost workdays and sick leaves when drinking water in a Finnish town was contaminated with waste water. However, this study does not include residents' direct costs to replace water, such as the cost of drinking bottled water. Similarly, Corso (2003) estimate lost productivity and health costs, but fail to account for water replacement costs. In May, 2000, Walkerton, Ontario experienced an eight month disruption of water service, an event which stands out for its unusual severity. Livernois (2001) extensively analyzed this event, building on the ground breaking work by Harrington et al. (1989). In 2008, Alamosa, Colorado experienced an outbreak of *Salmonella* where approximately twenty percent of household respondents reported becoming ill with diarrhea. Ailes et al. (2013) provided the most complete estimate of the economic costs of a water contamination event to date through a survey of these residents. Again, however, the focus is somewhat narrow and misses the behavior changes that happen at the household level to manage a water disruption. The research does include costs associated with water replacement and travel, but only includes changes in productivity related to illness. Some changes in productivity, however, occur to manage the disruption in the water service itself. For example, residents must change how they eat and cook. And, because the Ailes, et al. and Livernois studies both cover unusually large events, they tell us little about more common water outages or contamination events that do not cause widespread illness.

A related body of research exists in the emergency preparedness literature that documents the economic costs associated with catastrophic, widespread events, such as earthquakes and floods (Rose, 2004; Rose & Lim, 2002; Tierney, 1995). These studies document the resiliency of industries and their economic costs in the face of water outages. But in these cases, the costs of losing water service are difficult to separate from the costs of infrastructure damage. Other studies (e.g., Bay Area Economic Forum, 2002; Brozovic, Sunding, & Zilberman, 2007; Chang, Svekla, & Shinozuka, 2002) use *potential* earthquake scenarios to estimate the economic damage from disruption to water service. For example, Chang et al. (2002) surveyed businesses in Memphis, Tennessee about their ability to operate if a *hypothetical* earthquake disrupted water service. This literature provides important context for our study. However, these studies are about widespread disruptions, and our interest is in examining the costs of water disruption events that are localized, brief and common.

Currently, the extent literature provides little information on the costs residents can expect during short, targeted water disruptions. Water contamination events are the most studied, but they usually use a single case study method and focus only on the costs associated with illness. It is unclear how results might vary by region, or if there are no moderate or severe health effects to observe. The surveys of real or hypothetical disasters are helpful, but in those studies it is difficult to accurately isolate the costs of the water loss from the costs of disruption to electric, communication and transportation infrastructure. Finally, the prior research on residential costs of water disruptions is limited because it usually assumes a set number of gallons per day and cost. It does not take into account residents' actual costs when they change behavior to manage water loss. In this study, we address these limitations by surveying residents in four locations about their behaviors when they recently experienced a water disruption.

2. Methods

We use focus groups and in-person surveys conducted with residents in 2012 to document the economic costs of water outages and water contamination events. As a consequence, all monetary values are expressed in 2012 dollars.

2.1. Resident focus groups

We conducted three focus groups for this project. The goal of the focus groups was to explore how experiences might be different during the three types of water disruptions: a water system "boil water" advisory, a contamination warning, or a complete water outage. The focus groups followed a semi-structured interview protocol. One researcher and two different research assistants conducted three resident focus groups in two locations (Ithaca, NY and Somerset, MA). We recorded the focus group discussions and later transcribed them for analysis.

2.2. Residential surveys

We collected 162 in-person surveys from four sites. We selected field study sites based on a national search of water disruptions. From this list, we excluded disruptions lasting less than one day and disruptions that occurred in areas smaller than one zip code. We tried to include water disruptions of various types (e.g., contamination events and outages) and that occurred in sites of varying population (i.e., rural and urban). Teams of trained graduate students conducted 15 min face-to-face residential surveys in the four locations with a convenience sample of residents. We created English and Spanish versions of the survey tool and sent bilingual surveyors to sites where we expected a heavy number of Hispanic residents. Since we did not randomly sample survey respondents from the population at each site, answers may not represent the underlying population distribution and should therefore only be considered suggestive. We conducted interviews in May and June of 2012.[1] The survey interviews occurred between three and twelve months after the water disruption event; the shortest interval between the event and interview was in rural areas. For specific information on site characteristics and respondent demographics, please see Appendix A.

The survey asked respondents what they did to manage the water disruption, and how many days they adopted that behavior. There is variability in the number of days the costs were incurred within each event because respondents chose to lengthen or shorten the time behavioral adaptations were made. We then summed the costs in each category over the event. Therefore, the costs we present represent the average total household costs for the event instead of the more common per capita, per day costs of disruption (Aubuchon & Morley, 2013).

[1] The events respondents were asked about ranged in time from May 31, 2011 to March 12, 2012—a period of under 12 months. Consequently, we did not attempt to adjust for inflation.