Behavior Watersheds: Examining the Geospatial Distribution and Impact of Behavior Change Programs

Susan Mazur-Stommen and Kate Farley,
American Council for an Energy-Efficient Economy

ABSTRACT

The Behavior Program staff at the American Council for an Energy-Efficient Economy looked at the geographic distribution of utility-run behavior-based programs using a "hydrological" metaphor to account for potential anomalies of effect on energy savings. We hypothesized that, in areas of overlap across utility territories where different entities have responsibility over gas, electricity, and water distribution, a "flood" or "drought" model will prevail. The ability to represent the spread of behavior programs geographically using geographic information systems (GIS) software is an exciting development. We used Quantum GIS (commonly called QGIS), which is an open-source equivalent of the industry-standard software package, ArcGIS. When we looked at the "watersheds" for each utility running behavior-based interventions, an interesting picture emerged. Utilities in some areas, such as California and the Northeast, have implemented behavioral programs across large territories. These overlap to some degree, especially when gas and electric utilities share the same customer base and geographic territories. While it may come as no surprise that some areas of the country are experiencing a "drought" with respect to behavior programs, the idea that other areas are receiving overwatering may be new. There is a potential danger that message fatigue might set in for customers in regions with a high concentration of programs, and that savings may go in retrograde due to overload—what has been called "message fatigue." Our recommendations are that, when designing a behavior-based program, utility implementers should take the environmental context of their messaging into account.

Introduction

The Behavior Program staff at the American Council for an Energy-Efficient Economy (ACEEE) looked at the geographic distribution of utility-run behavior-based programs using a "hydrological" metaphor to account for potential anomalies of effect on energy savings. This metaphor refers to our hypothesis that we can represent the different distribution of investment in behavior-based energy efficiency programs as a "drought" in areas with a dearth of programs, or as a "flood" in areas with significant investment and resultant unintentional overlap. We are testing our assumption that, in areas of overlap across utility territories where different entities have responsibility over gas, electricity, and water distribution, a flood model will prevail. We believe this metaphor, while not drawing upon real-world mathematical models of hydrological processes, provides a useful means of visualizing the range of effects behavior programs have on the customers in a utility territory.

This paper is representing the concentration of programs[1] in some geographic regions, and the dearth of programs in others. While it may come as no surprise that some areas of the

[1] This paper will not be representing the savings achieved by any specific program.

country are experiencing a "drought" with respect to behavior programs, the idea that other areas are receiving overwatering may be new. If the outlying ends of the range are either drought or flood, then our metaphor suggests that there may be an optimal amount of behavior programs appropriate for a geographically bounded region. This leads to our secondary hypothesis: We believe that a potential danger exists for "compassion fatigue" (Moeller 1999; Tester 2001) to set in for customers in regions with a high concentration of programs, and that behavior-based energy savings may go in retrograde due to this overload.

Among researchers who look at energy efficiency programs, there has been interest in the sequence with which customers encounter programs (Osterhus et al 2012), but as far as we are aware, none with respect to the effect of multiple, competing programs within the same broad regional territory. We ultimately seek to learn whether multiple programs running in adjacent or overlapping territories interfere with one another, depressing participation, engagement, and energy savings. We geared this paper toward program designers working for utilities with advanced levels of investment in measures aimed at changing energy-usage behaviors. This paper is less relevant for those designers with no extant programs; however, areas with nascent interest in behavior can potentially use GIS techniques to refine their initial plans and offerings. All findings are preliminary. In this paper, we are mostly interested in the applicability of GIS to these particular kinds of data sets, as well as their ability to generate interesting questions that can fruitfully drive future research and the development of tools for designers of energy efficiency programs.

ACEEE Field Guide to Utility-Run Behavior Programs

In the recent *ACEEE Field Guide*, we encouraged the use of what we called "stacking," which promotes the strategic application of behavioral programs within a well-designed portfolio of initiatives aimed at saving energy and meeting targets in lieu of the indiscriminate use of multiple behavioral programs. In order to achieve a "stack," or an otherwise balanced portfolio of offerings, utilities need to offer a diverse set of approaches that individually touch upon various aspects ("drivers") of human behavior. We consider that a well-balanced approach would include programs[2] that focus on the cognitive, calculus, and social sets of drivers:[3]

- Cognition: Programs where intrinsic psychological processes are foremost
  - E.g., communication campaigns and educational efforts
- Calculus: Programs where the deliberation of extrinsic aspects play a primary motivating role
  - E.g., feedback and game-based programs
- Social interaction: Programs whose key drivers are sociability and belonging
  - E.g., person-to-person and online forums

By asking program designers to "stack" their behavior portfolio offerings, we were asking them to go beyond simply initiating behavior-based energy efficiency and to begin to do it strategically, with an eye toward deeper savings and longer-lasting impact. In this paper, we are again raising the bar, asking not only designers, but also regulators and state energy officials

[2] For the full taxonomy of behavior programs, please refer to the *Field Guide*.
[3] We discuss these in greater detail in the *Field Guide*.

to begin to think about statewide, and even regional, strategies for behavior programs. Our work on this project is an extension of work that we did for the ACEEE *Field Guide* project. That project helped spark some valuable conversation about the use of behavior programs in utilities, but in the interest of clarity, some secondary aspects of utility-run behavior programs went unaddressed. We seek to take that conversation a step further by focusing on geographic elements and providing additional angles for program designers to consider.

Concentration of Behavior

There has been a strong uptick of interest in behavior programs in recent years. The majority of programs we documented for the *Field Guide* began after 2007. At the same time, they cluster in four regions of the country: the Northeast, the Northwest, California, and the Great Plains.[4] Therefore, the phenomenon we are looking at is both recent and localized. One of the challenges that potentially could influence the effectiveness of behavior programs is their spatial distribution in relation to one another.

As behavior programs become more popular with utilities, problems may arise as messaging and influence overlap. A pioneering utility that invests in the first behavior program in a large geographic area does not have to worry about this problem, but when several utilities in a relatively densely populated area implement energy efficiency programs, it becomes important to consider potential cumulative and overarching effects upon customers in utility service territories. Unlike installed, physical measures, human behavior is complex and rife with the potential for unintended consequences. In a region where multiple utilities offer behavior programs, there could be a danger that consumers could overload on energy efficiency messaging, resulting in unanticipated behavioral effects and diminished savings.

We began our research with the assumption that the impact of a utility program extends over the strict borders of a particular service territory. For example, some customers who receive a home energy report might talk to their friends and neighbors about the program, creating an unintentional pass-along effect that causes the program's influence to bleed over the edges of the utility service territory boundary. Our hypothesis is that the mode of delivery of messaging matters with respect to behavior change and subsequent energy usage. In order to optimize program delivery, utilities might want to pay particular attention to areas of unintentional overlap, where customers may be receiving the same message multiple times.

In areas where an unintentional overlap of messaging takes place, we also hypothesize that a potential dilution of effect may manifest itself through "compassion fatigue." This is a term and a concept explored and popularized in two books that appeared close together at the turn of the millennium: Susan Moeller's *Compassion Fatigue: How the Media Sell Disease, Famine, War and Death* (1999), and Keith Tester's *Compassion, Morality and the Media* (2001). While these two books were primarily about how the public reacts to calls for aid in the face of "distant suffering," the term has also been picked up and used by other authors in discourses about climate change (Höijer 2010) and general "green messaging" (Strother and Fazal 2011). The concept of compassion fatigue has been called "somewhat nebulous and still understudied" (Joye 2013), but we feel that it is a useful analytic construct, sometimes also referred to as "altruism fatigue" and "message fatigue." While we think that authors have used the concept somewhat uncritically, it is useful as a metaphor, and as a jumping-off place for testing a

[4] They are not exclusively located in these regions, but there is a pronounced pattern.

potential effect in the real world. Our argument in this paper is essentially that piling on behavioral programs without looking at their effect upon one another may have its own dangers.

We think that the ranking of positive effect might look something like this:

No programs < Some programs chosen at random < One well-chosen program < Stacked programs selected strategically

However, before we can establish whether any such messaging fatigue is setting in, we first must establish the relationship of behavior programs to geography and utility territories. If unintentional overlap among utility efforts is *not* occurring, the chance of message fatigue diminishes. If there is a high degree of unintentional overlap among utility efforts, then we assume that the probability of message fatigue will rise. Our first pass at answering this question will consist of locating “hot spots” where a relatively high degree of behavior program activity is taking place, and then drilling down for more information in interviews with local energy efficiency experts.

Methodology

Maps can be a useful tool for visualizing how neighboring programs can interact with one another. By considering this additional dimension of behavior program design using GIS, we hope to provide program implementers with another tool for developing successful, cost-effective programs. In parts of the country where not much behavior work is going on, this may not yet register as something to concern program managers, but if behavior programs are coming down the pike, they can get ahead of the curve and learn from the challenges experienced in other regions. During our *Field Guide* research, we conducted some initial spatial analysis work to see the distribution of behavior programs nationwide in terms of specific utility territories. At the time, we thought that this kind of analysis might be a useful tool for thinking through some issues of definition with respect to the deployment of behavior programs.

GIS 101

A geographic information system, or GIS, is a system for digitally creating and storing geographical data—in other words, for making computerized maps. GIS programs use a digital grid (often latitude and longitude, but sometimes another type of coordinate system) for representing real-world objects. GIS is useful to researchers in diverse applications, from city infrastructure planning, to modeling disease outbreaks, to keeping records of things like town boundaries. Users can input geographic information into GIS in two ways. The first is by essentially tracing elements like borders and roads on an existing map or in an aerial photograph in a process called digitizing. The second is for researchers to directly input survey data (for example) from the field, often in the form of global positioning coordinates (GPS). The benefit of using GIS is that it can help make complex sets of spatial data more easily comprehensible. GIS is a tool for interpreting diverse and complex sets of data, and it is more than simply a map representing the association of physical items in space; by visually displaying spatial data, we can often see patterns emerge that would otherwise be incomprehensible. In this project, we are specifically looking for areas of concentrated activity in the behavioral space. This kind of visualization will help utilities make decisions tailored to their needs going forward.

The industry-standard software for GIS is ArcGIS, published by Esri. ArcGIS is a very flexible program that is capable of performing a wide array of tasks, but subscriptions can be expensive, and the software only runs on Windows-based computers. For this project, we used an alternative GIS platform called Quantum GIS, or QGIS. QGIS is an open-source GIS platform that has much the same functionality as ArcGIS, and is available as a free download on the Internet. In both ArcGIS and QGIS, elements of maps are "features." Features can come in the form of polygons, lines, or points. A feature representing a lake, a census tract, or a state would be a polygon. A feature representing a road might be a line, and a feature representing the location of a hospital or school might be a point. Features can be assigned attributes, or data points, in table format. A GIS layer of polygons representing all 50 states might include attributes for state population, area in square miles, and number of congressional districts for each state.

For this project, we are representing the service territories of electric and natural gas utilities in the Northeast and Pacific Northwest as polygons. The analysis in this paper illustrates how our theory of behavior program droughts and floods might play out over real-world utility service territories. We used variables that we think have an impact on the way behavior messaging interacts with geography. However, additional research is necessary before we can get an accurate picture of how population density, number of programs, program participation rates, and any other variables interact with each other in reality.

Maps

The maps below are unique creations. These and the other maps we created in the process of writing this paper (sets of regional and multistate—even international—utility boundaries) do not exist as such in an easily accessible and publicly available location. Instead, such maps exist piecemeal, as proprietary designs in utility offices, as academic data in universities, or in public utility commission files. The process of constructing these maps was almost a craft in that we digitally 'traced' them from a variety of sources, including trade associations, public utilities commissions, and utilities' own websites. Because we based these maps on publicly available sources, we have the ability to share them freely.

The overlays of information in these maps begin to reveal relationships between utilities, programs, localities, and geographical features such as rivers. However, at this stage there is variation in the quality of input maps, most especially in the Pacific Northwest. In these areas, our maps are simplified representations of complex realities, rather than depicting deployment of programs with pinpoint accuracy. With additional time and resources, we could develop maps that capture the unique sets of variables affecting how programs play out on the ground. As discussed above, this project focuses on two geographic regions: the Northeast and the Pacific Northwest. The Northeast region includes the states of New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine, as shown in Figure 1

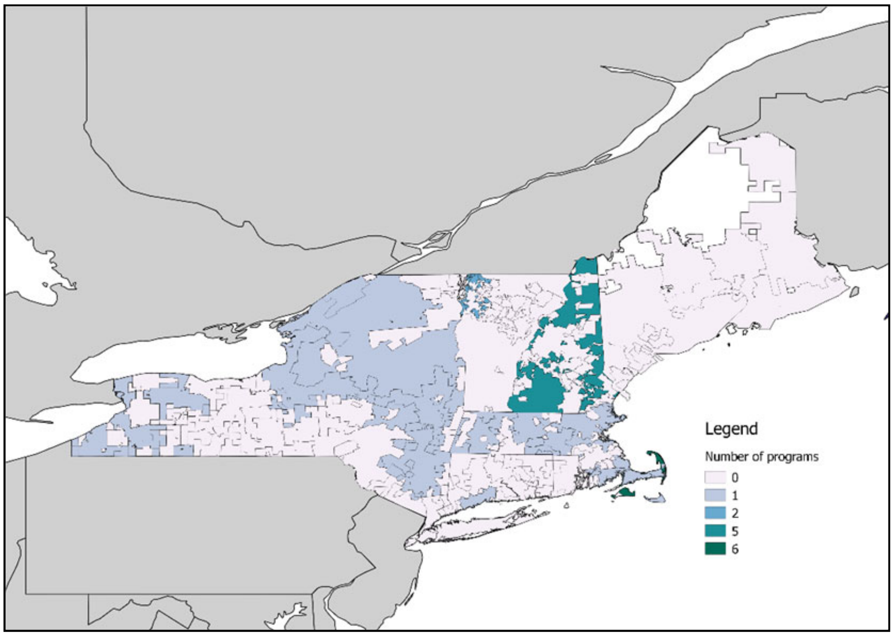

Figure 1. Electric utilities offering behavior programs in the Northeastern United States.

Meanwhile, the Northwest region includes Oregon, Washington, Idaho, and British Columbia, as shown in Figure 2.

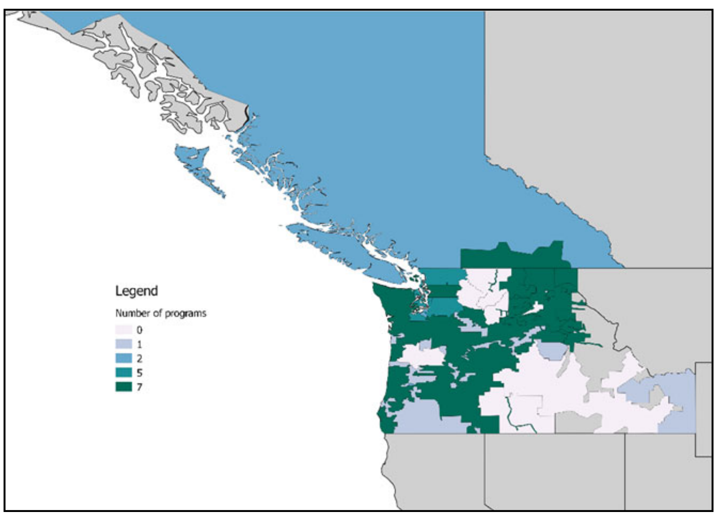

Figure 2. Electric utilities offering behavior programs in the Pacific Northwest.

The areas of the map that are shaded the darkest are the areas that were most likely to be experiencing a "flood" of energy efficiency messaging. The highest number of behavior-based programs we have found in any one territory to date is seven. When we look at the service territories of utilities that offer behavior programs, we can see a few trends. Perhaps unsurprisingly, many behavior efforts are concentrated in and around major metropolitan areas—

Boston in the Northeast and Seattle in the Northwest (notably, the region around Portland is a sudden void in the otherwise thorough distribution of behavior programs across the region). In a few instances, however, there are regions with lighter population densities (i.e., rural) where utilities are operating behavior programs. Figures 3 and 4 are maps of population density, with shaded regions indicating the locations of utilities offering behavior programs.

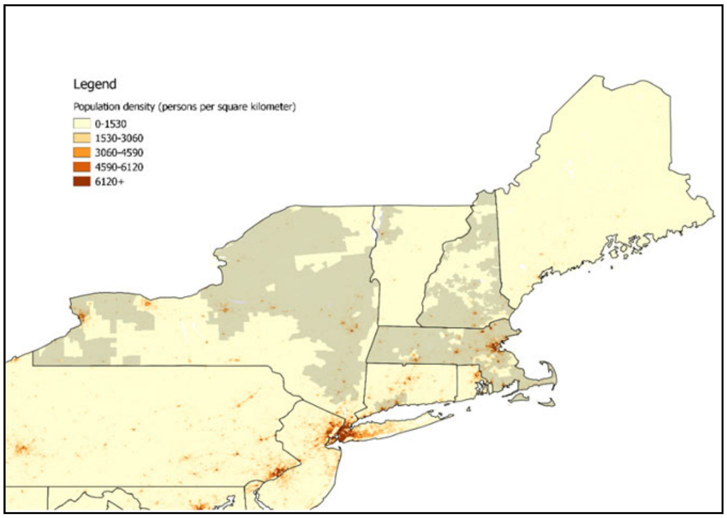

Figure 3. Population density and location of utility programs in New York and New England.

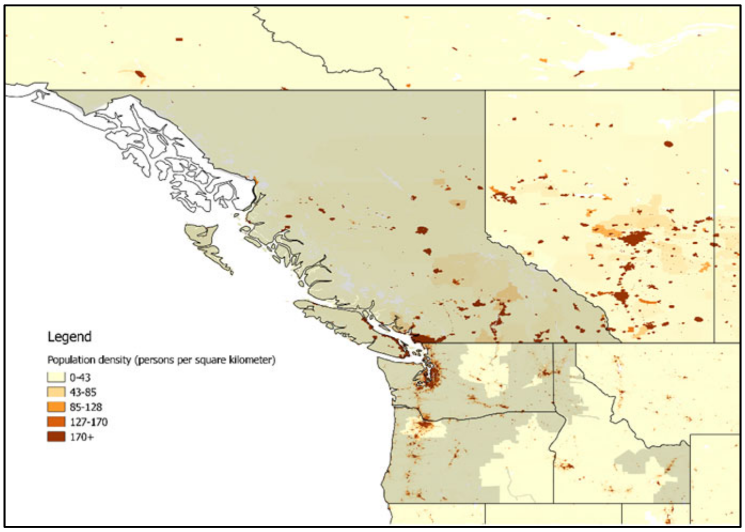

Figure 4. Population density and location of utility behavior programs in the Pacific Northwest.

There are several areas where the local gas utility and the local electric utility are *both* operating behavior programs. Following our hydrological metaphor, this increases the potential for a flood situation of unintentional overlap, where utilities in the same geographic area are distributing messages that may or may not be complementary. The maps in Figures 5 and 6 show the gas and electric utilities for each region superimposed on one another. The highlighted areas are the regions where the gas and electric utilities are both offering behavior programs.

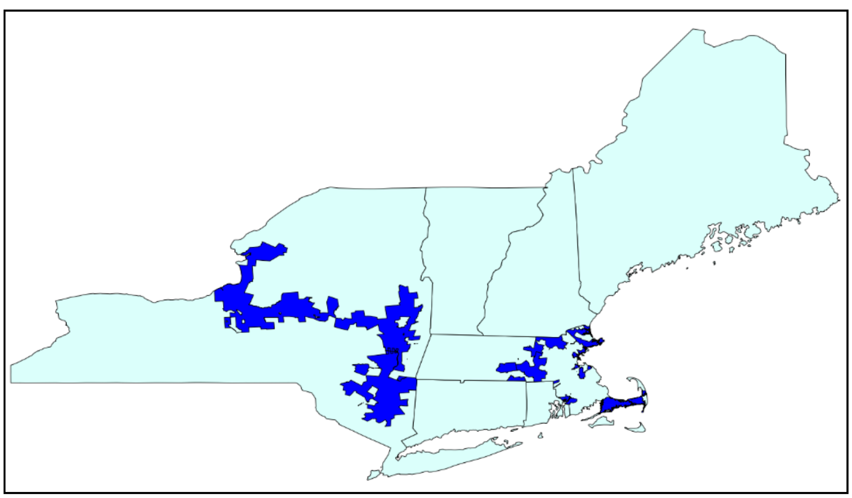

Figure 5. Map of areas in the Northeast where overlap between gas and electric utility behavior programs is occurring.

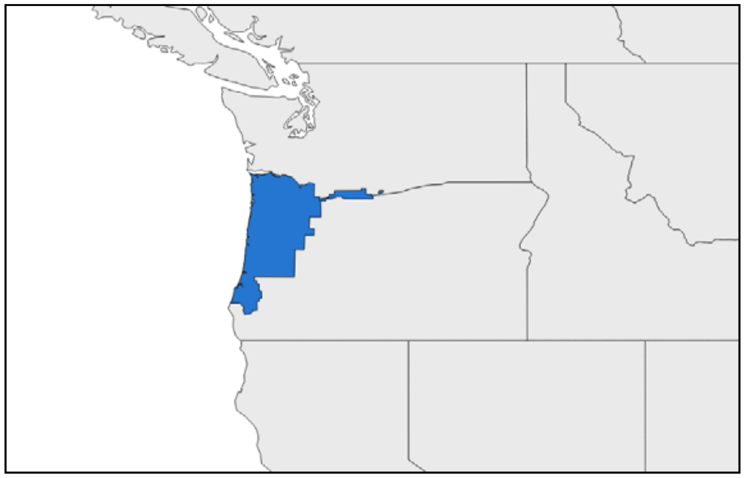

Figure 6. Map of areas in the Pacific Northwest where overlap between gas and electric utility behavior programs is occurring.

We interviewed two evaluators—one from each region—about behavior programs and whether they had seen issues with overlap. Both felt that it was a reasonable concern, but neither could point to specific evidence of it occurring. While we were hoping for some anecdotal evidence, we knew the chance of actual data would be slim due to evaluation, measurement, and verification rarely being coordinated across all utility types in a region: investor-owned utilities, municipal utilities, and co-ops. Each of these types operates under separate regulatory oversight, so coordination regionally is rare. We did however, find some evidence that messaging and its consumption varies geographically in the *Massachusetts Umbrella Marketing Evaluation Report* by Opinion Dynamics (2012). Opinion Dynamics found that "focus group research with residential customers suggests that awareness of Mass Save differs across the geographic areas of the state." This is particularly interesting given the statewide coordination of the Mass Save campaign. A campaign coordinated statewide through utilities should reach customers directly through their bills. The idea that there is a geographic component to message reach has potential as a future research topic.

Given that we began with a hydrological metaphor of behavior "watersheds," it is worth noting that the overlap of behavioral programs in the New York portion of the map above roughly approximates the paths of the Mohawk and Hudson rivers. This is likely an artifact of the data, shaped by the historical nature of both utility boundaries and the age-old relationship between water and power, one that pre-dates electricity but is still shaping outcomes today (Besha 2011):

> A 1908 New York State map shows a generous number of water power developments across the state. Within the Mohawk Watershed, the map indicates 68 developments with generation ranging from less than 100 to as much as 7,000 horsepower. Most of the developments powered grain mills, saw mills or other industrial operations.

We looked at the other behavioral "flood zones" to see if they were also mimicking their natural world analogs. The behavior flood zone in Massachusetts does not seem to have a real-world analog, but in the Pacific Northwest, the overlap of gas and electric utilities offering behavior-based programs mimics the natural watershed of the Columbia and Willamette Rivers, where they meet and empty into the Pacific.

Conclusion

The Behavior Program staff at ACEEE looked at the geographic distribution of utility-run behavior-based programs. We used Quantum GIS, an open-source GIS software package, to develop maps representing utility service territories, to which we assigned attributes (population density, program type). With behavior programs already highly localized in time and space, we zeroed in on two regions for comparison and analysis: the Pacific Northwest and the Atlantic Northeast (from New York to Maine). Time and funding constraints prevented us from conducting this analysis on all of the United States and Canada, though we expect that we will be able to find more significant spatial relationships if we are able to do an expanded analysis at a later date. We found areas with concentrations of behavior programs and spoke with local utility program experts about their experience working in these areas.

Using GIS to analyze behavior program data brought distinct advantages and disadvantages. The ability to concretely represent information and the spatial relationships among utilities and the programs they run provided the impetus for asking new questions about outcomes. For example, we are aware that specific program designs might result in very specific geographical outcomes due to targeting of particular populations (e.g., spatial distribution of low-income program participants) and that this paper does not capture that. Instead, we intend the maps, and the accompanying discussion, to begin a conversation about utility behavior programs and their relationships to such variables as geographic boundaries, population densities, and even natural features. These maps matter because, as mentioned above, due to the varying regulatory bodies of different types of energy providers, coordination of programs can be complicated and lack transparency. With these maps, program designers can better see where their efforts may be "bumping up" against those of an adjacent provider.

Next steps

Our goal was to represent and understand the interplay between programs offered by multiple utilities with overlapping sets of customers. At a minimum, we wanted to include gas utilities, as we found that a fair number of the larger gas utilities offer behavior programs. Optimally, we would also include water utilities, which are behind energy providers in terms of smart meters and messaging campaigns, but are likely to catch up, as players such as WaterSmart (which is to water utilities what Opower is to energy providers) come on the scene.

We believe that a potential danger exists for compassion fatigue to set in for customers in regions with a high concentration of programs, and that behavior-based energy savings may go in retrograde due to this overload. At this time, we have not collected evidence that accidental overlap in messaging is affecting outcomes in terms of program participation and behavior change. Our maps do not reflect the effects of messages having an impact beyond the borders of the utility service areas. However, by pinpointing the areas of unintentional overlap, we can now look for differences in behavior related to over-messaging. In order to more precisely model the impact of behavior programs on neighboring regions, we would need to calculate the zones of influence of utility service territories with behavior programs based on several parameters not covered in this brief paper:

- Utilities that offer a greater number of programs and programs with more participants would have a greater influence on surrounding territories.
- Utilities with higher population density within the service territory and larger geographic size would also have a relatively greater influence on neighboring areas.

As we look to the future, the question becomes "What kind of research is needed to make GIS findings more robust and useful?" A centralized, public location for program data with consistent metrics and reporting parameters would pay dividends in terms of heightened understanding of this kind of relatively subtle interaction effect. We found that we would need to think more about:

- Hierarchies of program providers
- Granularity of geographical data
- Access to other types of data (e.g., student status)
- The addition of water utilities, and perhaps also waste disposal

We recommend that utility implementers take the environmental context of their messaging into account when designing a behavior-based program. What other similar efforts may be underway in the same territory? Can a natural gas utility take advantage of groundwork laid by a campaign produced by an electric utility? Might it make sense to share data about the impact of certain communication efforts regionally? Our initial researches uncovered more questions than answers, which provide directions for future endeavor.

References

Baseman, J. G., D. Revere, I. Painter, M. Toyoji, H. Thiede, and J. Duchin. 2013. "Public health communications and alert fatigue." *BMC Health Services Research* 13 (1): 1-8.

[CIESIN] Center for International Earth Science Information Network, Columbia University; International Food Policy Research Institute (IFPRI); the World Bank; and Centro Internacional de Agricultura Tropical (CIAT). 2011. Global Rural-Urban Mapping Project, Version 1 (GRUMPv1): Population Density Grid. Palisades, NY: Socioeconomic Data and Applications Center (SEDAC), Columbia University. Available at http://sedac.ciesin.columbia.edu/data/dataset/grump-v1-population-density. [May 19, 2014].

Besha, J. A. 2011. "Hydroelectric Power in the Mohawk River Watershed: Past, Present, and Future" In Proceedings of the 2011 Mohawk Water Symposium. Schenectady, NY: Union College. http://minerva.union.edu/garverj/mohawk/2011_symposium/3_Besha.pdf.

GRANIT database [computer file]. New Hampshire Political Boundaries at 1:24,000 Scale. Durham, NH: Complex Systems Research Center, University of New Hampshire. Available: http://www.granit.sr.unh.edu/cgi-bin/nhsearch?dset=pb/nh [March 3, 2014].

Höijer, B. 2010 "Emotional anchoring and objectification in the media reporting on climate change." *Public Understanding of Science* 19 (6): 717-731.

Joye, S. 2013. "Interview with Philippe Henon, press and communication manager of UNICEF Belgium," *Participations, Journal of Audience and Reception Studies* 10 (1)

Maine Office of Geographic Information Systems [computer file]. 2014. Town Boundaries (METWP24) and Geocodes Tables. Augusta, ME: Maine Office of Geographic Information Systems. Available FTP: http://www.maine.gov/megis/catalog/shps/state/metwp24s.zip [March 3, 2014].

"Maine Transmission & Distribution Utilities" [map]. (n.d.). http://www.maine.gov/mpuc/electricity/ElectricSupplier/t&d.htm [August 1, 2013].

MassGIS [computer file]. 2014. Community Boundaries (Towns) from Survey Points. Boston, MA: Massachusetts Executive Office of Administration and Finance. Available FTP: http://wsgw.mass.gov/data/gispub/shape/state/townssurvey_shp.zip [March 3, 2014]

----. [computer file]. 2009. Public Utility Service Providers. Available FTP: http://www.maine.gov/mpuc/electricity/ElectricSupplier/t&d.htm [March 3, 2014].

Opinion Dynamics Corporation. 2012. "Massachusetts Umbrella Marketing Evaluation Report." http://www.ma-eeac.org/Docs/8.1_EMV%20Page/2012/2012%20General%20Studies%20&%20Presentations/Mass%20Save%20Report%20FINAL%202012-06-19.pdf. Waltham, MA: Opinion Dynamics Corporation.

Moeller, S. D. 1999. *Compassion fatigue: How the media sell disease, famine, war and death.* London: Routledge.

New York State Department of Public Service [computer file]. 2001. Electric Service Territories. Albany, NY: New York State Department of Public Service. Available: Columbia University Spatial Data Catalog

----. [computer file]. 1999. Gas Service Territories. Albany, NY: New York State Department of Public Service. Available: Columbia University Spatial Data Catalog

"Northwest Utility Control Areas" [map]. 2004. http://www.bpa.gov/news/pubs/maps/NW_Utility_counties.pdf [August 8, 2013].

RIGIS. [computer file]. 1989. Municipalities. Providence, RI: RIGIS. Available FTP: http://www.edc.uri.edu/rigis/spfdata/boundaries/towns.zip [March 3, 2014].

State of Connecticut, Department of Environmental Protection [computer file]. 2006. Connecticut Town Polygon. Hartford, MA: State of Connecticut, Department of Environmental Protection. Available FTP: ftp://ftp.state.ct.us/pub/dep/gis/shapefile_format_zip/Connecticut_Town_shp.zip [March 3, 2014]

State of New Hampshire Public Utilities Commission. 2004. "Core Electric Utilities Service Areas" [map]. https://www.nhsaves.com/about/state.PDF [August 8, 2013].

"State of Vermont Electric Utilities Franchise Areas" [map]. 2010. http://www.docstoc.com/docs/23833244/State-of-Vermont-Electric-Utilities-Franchise-Areas [March 5, 2014]

Strother, J. B. and Z. Fazal. 2011. "Can green fatigue hamper sustainability communication efforts?" *Professional Communication Conference (IPCC), 2011 IEEE International*. Cincinatti: IEEE http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6087206&isnumber=6087180

Tester, Keith. 2001. *Compassion, morality, and the media*, Open University Press, Philadelphia

Osterhus, Tom, May Wu, Michael Ozog, Yuhui Qiu and Patricia Thompson. 2012. Residential Demand Response Marketing Education & Outreach Exploratory Baseline Study for Program Year 2012,

VGCI [computer file]. 2012. BoundaryOther_BNDHASH. Waterbury, VT: Vermont Center for Geographic Information. http://maps.vcgi.org/gisdata/vcgi/packaged_zips/BoundaryOther_BNDHASH.zip [March 3, 2014].