NFIE-Response in Cache County, Utah

a Term Project for CE 397 Flood Forecasting
by Madeline Merck, 8 May 2015

Introduction

Project Objectives & Deliverables

The component of the National Flood Interoperability Experiment (NFIE) that is being investigated in this term project is NFIE-Response, a wide area plan for flood response developed with local emergency response communities throughout the nation. As defined within the NFIE conceptual framework, NFIE-Response includes a *planning phase* to identify vulnerable people, infrastructure, and roads, and an *action phase* that uses flood forecasts and flood inundation mapping to indicate zones of flood risk during a flood event. The purpose of the project is to gather, preprocess, and analyze as much existing and available data as possible for Cache County, Utah, (Figure 1) in an effort to become familiar with the area in preparation for the NFIE Summer Institute. The intended objective of this term project was to perform a case study in Logan, Utah, which is located in Cache County. The case study was to include: 1) construction of the NFIE-Response database maps for Cache County, 2) an assessment performed along side the local emergency response community of the data available for informing the Cache County NFIE-Response planning and action phases, and 3) evaluation of the estimated FEMA inundation maps for a portion of Logan alongside the actual area of inundation mapped via lidar in June of 2011 when the Logan River nearly reached 100 year flood flows. However, due to difficulty accessing usable data (i.e., reliable and whole, with appropriate accompanying metadata) and a surprisingly nonresponsive local emergency response community, very little of the original objective was completed. Therefore, suggestions for future work on NFIE-Response are discussed based on a small example case study located in Logan City.

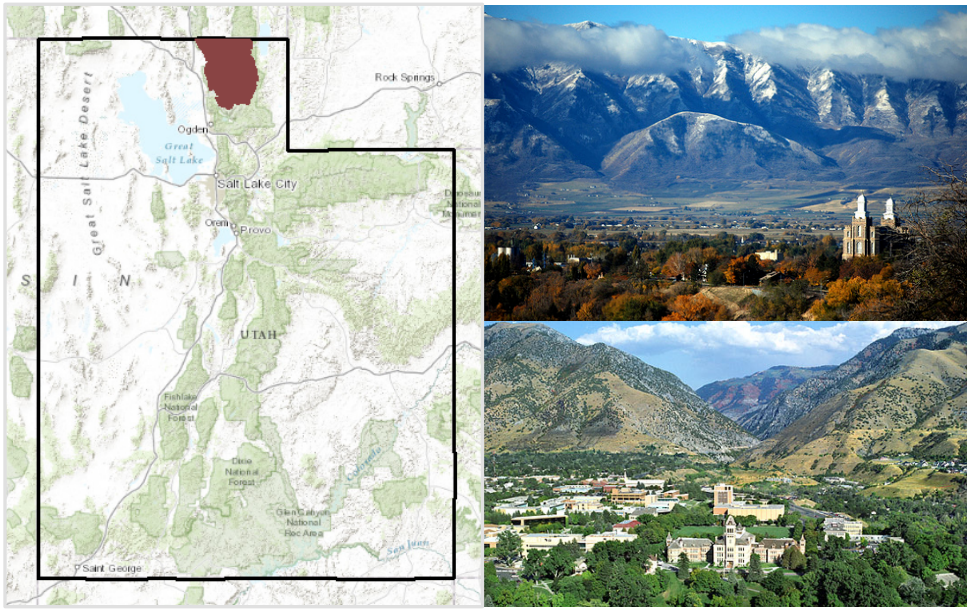

Figure 1: (Left) A map of the State of Utah showing the location of Cache County (in brown). (Top Right) Looking west toward the Wellsville Mountains. (Bottom Right) Looking east toward the Bear River Range and up Logan Canyon.

Cache County

Cache County is located in northern Utah (Figure 1, left). It covers upwards of 1,200 square miles and its population in 2014 was estimated to be approximately 118,000 [1]. The county is surrounded by mountains in all directions except its northern border, which it shares with Idaho. The Wellsville Mountains form its western border (Figure 1, top right), the Bear River Range forms its eastern border (Figure 1, bottom right), and the intersection of the two ranges forms its southern border. Logan City, the Cache County seat, is located at the center of the county in Cache Valley and is home to nearly half the county's residents. The Logan River originates in the Bear River Range flowing down Logan Canyon and through Logan City on its way to joining the Little Bear River in the wetlands floor of Cache Valley. The two rivers feed the southern portion of the Cutler Reservoir. The Bear River also flows through Cutler Reservoir and then the Wellsville Mountains on its way to feeding the Great Salt Lake.

Data & Methods

The intent of this project was to investigate as much existing and applicable data as possible before initiating any modeling efforts or emergency response planning for the NFIE Summer Institute. A natural starting point was to build the NFIE-Geo database and then the NFIE-Response database on top of it. The local emergency response community was then contacted for collaboration. And, finally, a case study was performed.

NFIE-Response Database

The following data was obtained in order to construct maps in ArcGIS for the NFIE-Response database for Cache County:

- NFIE-Geo Database layers for Cache County from the NFIE Great Basin Region [2]
- Address points of infrastructure within Cache County [3]
- Transportation network for the State of Utah [4]

Emergency Response Community

The original project proposal included an assessment of the strengths and weaknesses of the NFIE-Response maps developed for Cache County. The intent was for the local emergency response community to aid in this assessment because the maps are an example of the existing data and information that is currently available to them during a flood event. The emergency response personnel from Cache County and Logan City with whom communication was sought include:

- Cache County Sheriff
- Cache County Emergency Management Coordinator
- Cache County Search and Rescue Water Rescue Lead
- Logan City Fire Chief
- Logan City Emergency Management Coordinator
- Logan City Engineer
- Logan City Assistant Engineer
- Logan City 911 Dispatch Center

Logan Case Study

In lieu of a case study assessing NFIE-Response in Cache County for Logan City as a whole, an example location was chosen for review. The location is an at risk residential property along the Logan River. Data used in the case study include the above mentioned NFIE database maps and the following:

- Lidar of a portion of the Logan River [5]
- National Flood Insurance Program Flood Insurance Rate Maps for Cache County [6]
- Personal photos of the authors and USU water lab staff

Results

NFIE-Response Database

An example NFIE-Response database map for Cache County was constructed in ArcGIS. First, the NFIE-Geo database map (Figure 2, left) was constructed for Cache County using files from the NFIE Great Basin Region available on HydroShare. Address points and roads layers were then added and intersected with the flowlines and floodplain layers from NFIE-Geo in order to construct new layers describing vulnerable addresses and roads within Cache County (Figure 2, right). The vast majority of Cache County's address points are in the low-lands of Cache Valley; however, the road-river intersections are spread throughout the county.

Several neighborhoods throughout the county can be identified as vulnerable. For example, the neighborhood shown in Figure 3 experienced flooding during the 2011 Logan River flood. It also appears that this neighborhood would be cut-off from major roadways under 100-year flood conditions.

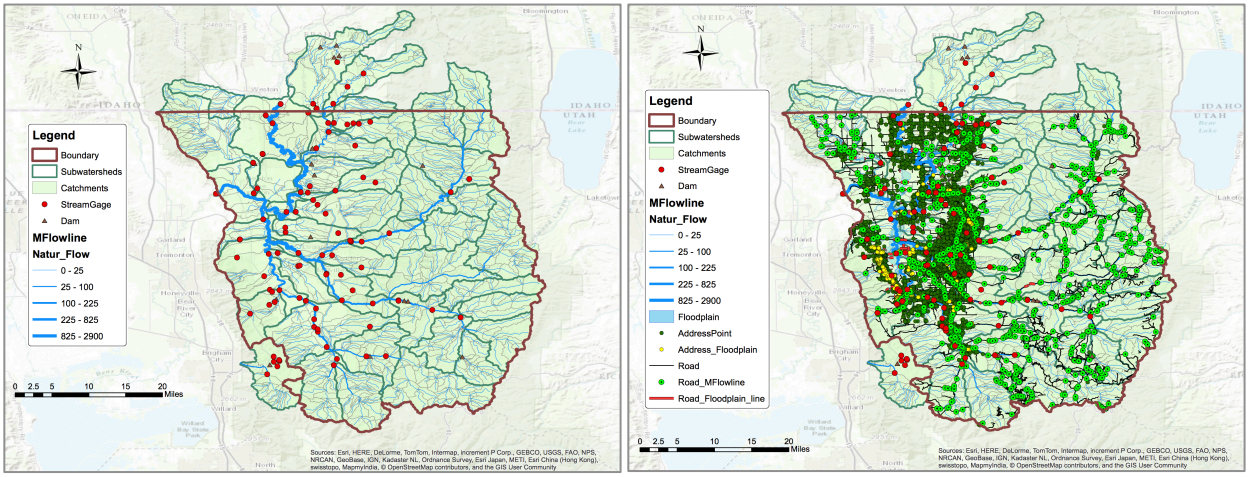

Figure 2: (Left) The NFIE-Geo database map for Cache County, including Subwatersheds, Catchments, Flowlines, Stream Gages, and Dams. (Right) A rather cluttered view of the NFIE-Response database map for Cache County.

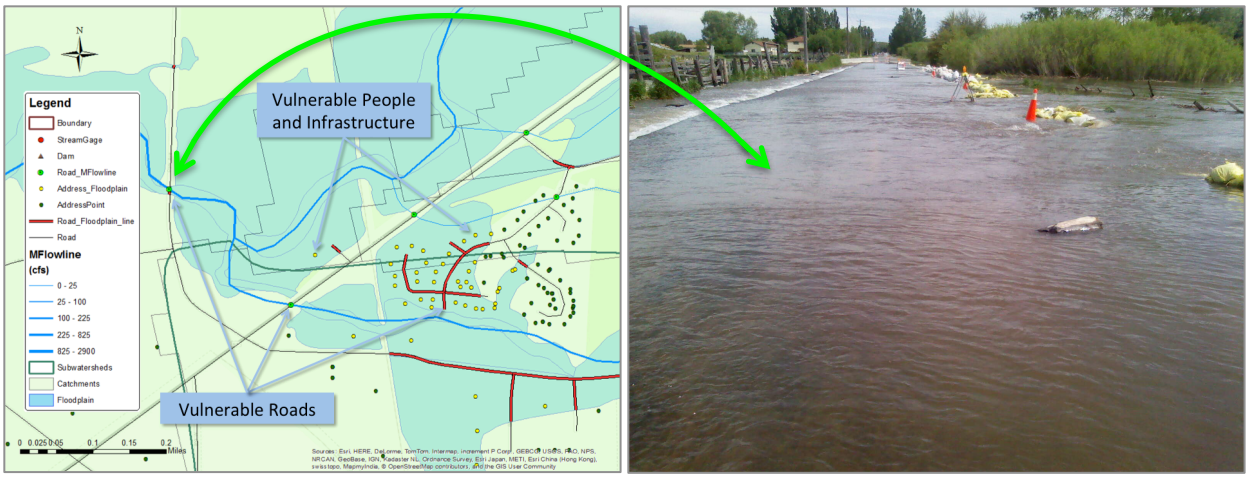

Figure 3: (Left) An example of the NFIE-Response database map for a neighborhood in Logan where homes and roads appear to be within FEMA's 100-year floodplain. Yellow dots are homes within the floodplain; green dots are homes out of the floodplain. Red lines are roads within the floodplain and lime green dots are intersections of flowlines and roads. (Right) A photo taken on June 16, 2011, along 600 West at 1600 South (lime green dot with double sided arrow). On this day, the discharge and stage were 1550 cfs and 5.2 ft and the Logan River was approaching its peak annual flow.

Emergency Response Community

It was not anticipated that virtually no communication would be established after several attempts by Harry Evans and myself at contacting both the county and city level emergency response community and inquiring about their involvement in this project through proper protocol. Communication was established with only two of the eight personnel that were contacted, the Search and Rescue member and a staff member at the 911 Dispatch Center. Due to nearly a complete lack of interest by the local emergency response community in participating in the discussion, the assessment component of this project was abandoned.

Logan Case Study

Between a deep snowpack and late spring melt, the 2011 annual peak streamflow of the Logan River was the latest on record and greater than the 90th percentile historic flow (Figure 4). At 1710 cfs, the peak streamflow was nearly 20 times its baseflow (baseflow ≈ 100 cfs,) and occurred almost a month later than usual (peak streamflow day ≈ June 1).

Figure 5 shows the location of the neighborhood used as the example case study site. The areas of interest are the residential property and the two bridges flanking the residential property on the Logan River. The bridges are of interest because one is visible on all the maps (western bridge) while the other is only visible on the aerial map (eastern bridge). The residential property is of interest because, according to information given on some the maps, it is not within the 100-year floodplain and therefore is not considered a vulnerable property nor is it required to carry flood insurance. However, the elevation of the house on the property is no more than 4534 feet, which is lower than the two closest "base flood elevation" values (4535 and 4539 feet), or 100-year flood water surface elevations, listed on the National Flood Insurance Program Flood Insurance Rate Map for Cache County.

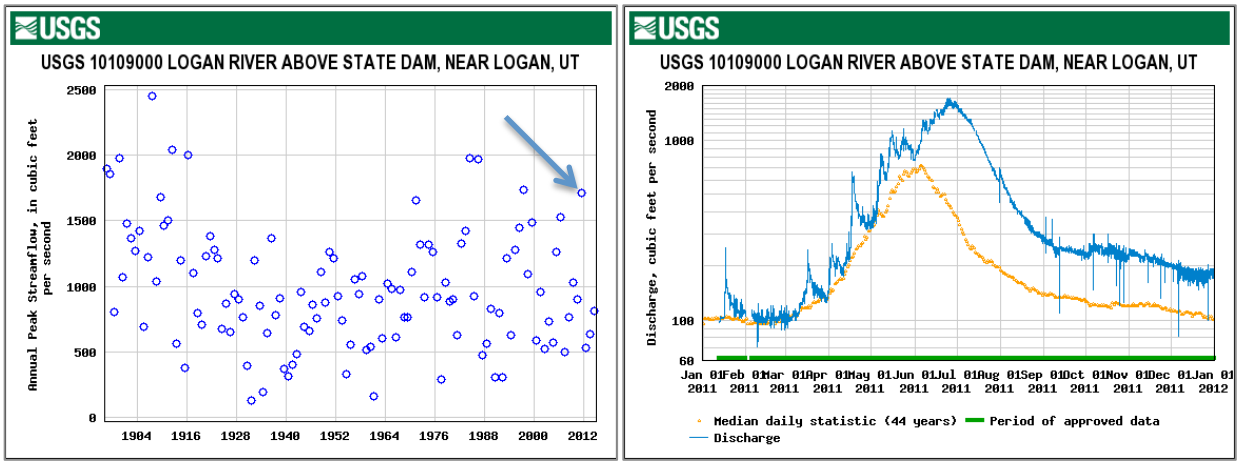

Figure 4: (Left) Annual peak streamflow of the Logan River at the State Dam USGS gaging station; note the peak annual streamflow for 2011 (blue arrow). (Right) Logan River discharge at the State Dam USGS gaging station for the 2011 calendar year; note the late timing and high flow for 2011 (blue line) relative to the median values (orange line). [7]

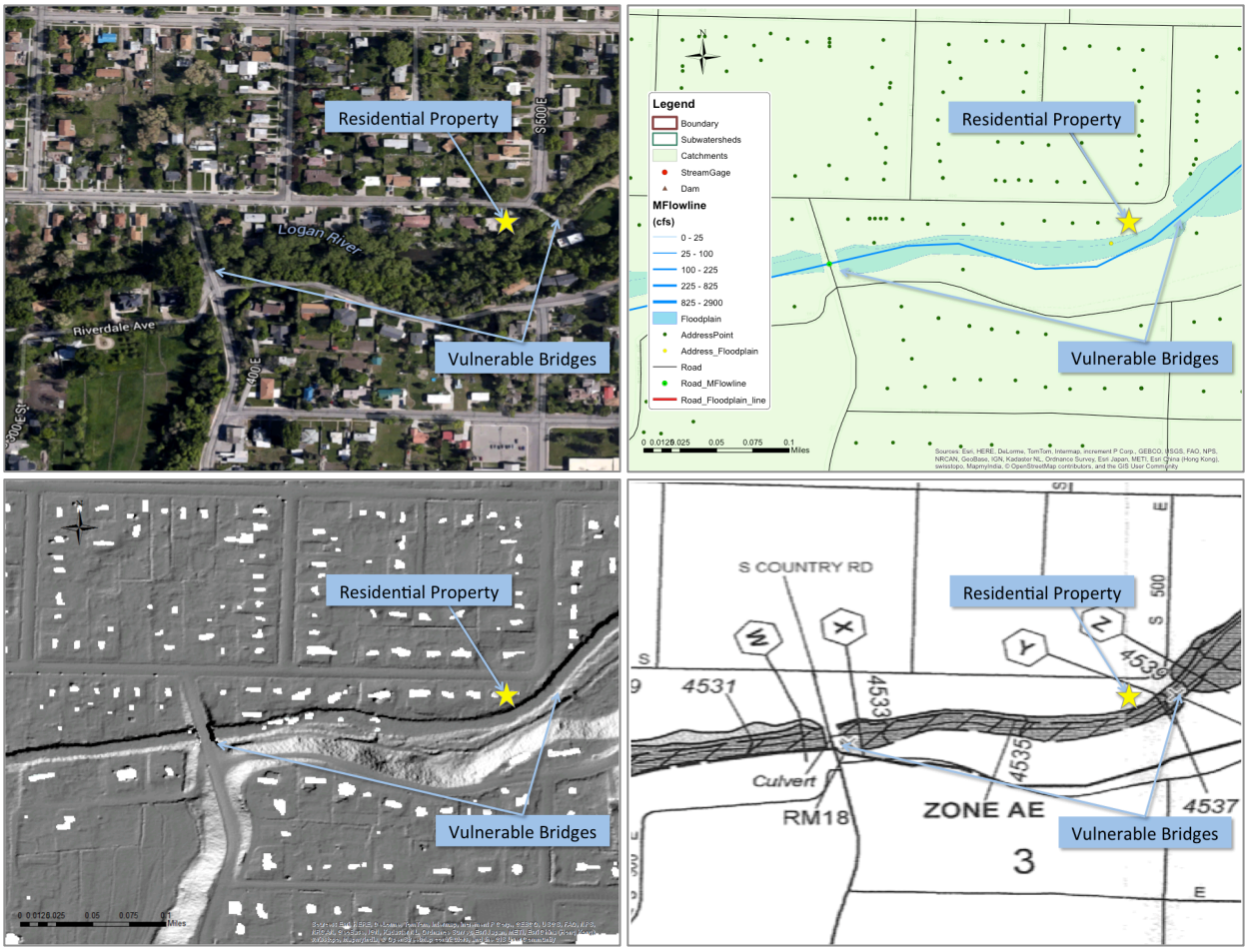

Figure 5: Various maps of the residential neighborhood along Logan River where the example residential property and vulnerable bridges are located. (Top Left) An aerial view using Google Maps. (Top Right) The NFIE-Response database map. (Bottom Left) Lidar with hillshade. (Bottom Right) The National Flood Insurance Program Flood Insurance Rate Maps for Cache County.

An example of the surveyed elevation markers placed in the yard of the property defining the 100-year floodplain is shown in Figure 6. Also shown are examples of high and low water surface elevations next to the property and flowing closely under the eastern bridge.

Figure 6: (Top Left) A surveyed elevation marker placed in the yard of the property defining the 100-year floodplain; also shown are the sandbags placed in the yard by Logan City. The top of the sandbag wall is lower than the elevation of the marker. (Top Right) A view of the river on June 25, 2011, the day of the annual peak streamflow in Logan River, 1710 cfs; note the surface water elevation with respect to the lawn and the underside of the bridge. (Bottom Left) A view of the residential property from across the river. (Bottom Right) A similar view of the river on April 27, 2015, when the streamflow was 165 cfs; again, note the surface water elevation with respect to the lawn and the underside of the bridge. The camera for this photo would be below the water surface elevation with flow of 1710 cfs.

Discussion

The intent of this project was to become familiar with Cache County in preparation for the NFIE Summer Institute. The process began with building the NFIE-Response database. Communication was then initiated with the local emergency response community and a simple case study was performed. Lastly, in lieu of an assessment of NFIE-Response for Cache County with the local emergency response community, an assessment of one of the

citizen education and preparation tools currently in place for some communities around the nation will be addressed.

NFIE-Response Database

As would be expected in a county with a topography and layout like Cache County, the vast majority of address points are in the lowlands of Cache Valley and nearly none are in the surrounding mountains (Figure 2). This is typical of mountainous regions in the west. What was not expected is that the road-river intersections would be spread throughout the county. This seems to be an error rather than an accurate data layer within the database map. The source of the error is in the accuracy of the roads and flowlines layers. The roads and rivers both follow the canyons within the mountains, typically paralleling one another by a distance of no more than tens of feet. When the location or width of either layer is incorrect, then incorrect overlap can easily occur resulting in false intersections. However, it should be noted that canyon roads are inherently dangerous and even more so during high flow events. Therefore, though inaccurate, these data are still considered helpful.

Emergency Response Community

Abandoning the assessment component of this project due to the lack of interest in participation by the local emergency response community was a surprising and very telling turn of events. Success of the NFIE-Response component of the NFIE as a whole is heavily dependent upon participation of this very important piece of the community. The disparity in interest between Cache County and other counties involved in the NFIE (e.g., Travis County in Texas and Tuscaloosa County in Alabama) must be taken into consideration when designing and implementing the NFIE-Response protocols for the entire nation.

Logan Case Study

Spring runoff due to snowmelt produces annual high-flow events in the western states typically resulting in hydrographs with a single peak flow in spring (Figure 4). Flooding from these events is very different than flashfloods and these differences must be addressed in the design and implementation of the NFIE-Response protocols for the nation. First, these events are long-term. Water surface elevations rise over days or even weeks and therefore flood conditions can remain for days or weeks as well. Second, these events occur without fail every year to varying degrees. Therefore, the planning and preparation for these events can be very organized, methodical, and even habitual for the local community.

However, planning for the events must involve the citizens so they are informed of their responsibilities. For example, the case study of the residential property located on the Logan River resulted in many questions the owners should be asking themselves:

- What is the true location of the 100-yr floodplain in the neighborhood?
- What is the actual depth of the 100-yr floodplain on the property?
- Is the eastern bridge monitored by the city? Or is it the citizen's responsibility?
- What should have been done by the citizens for pre-flood preparation?
- Who should the citizens call if they need help protecting their homes?
- Do the homes along this section of the river actually need flood insurance?

Who should the residents of this neighborhood seek out to find the answers to these types of questions? As of now, unfortunately, it is not apparent in this community. Currently, the only possible option seems to be calling upon the local emergency response community or the city engineers; however, based on the lack of response displayed by those personnel when approached about these topics for this project, this option is not encouraging.

Future Work

An approach some communities are taking is to use 311, the N11 abbreviated dialing code assigned nationwide for non-emergency police and other government services [8]. The N11 codes allow a caller to connect with a particular local phone network location using the same 3 digits nationwide rather than a specific local telephone number that is typically 7- or 10-digits (i.e., calling 311 anywhere in the nation and being patched through to the appropriate local personnel rather than looking up a phone number each particular local personnel to be called). For example, 911 was first used sporadically throughout the nation in the late 1960s but was not a national phenomenon for at least another decade. Even though 911 is still not formally assigned a use by the Federal Communications Commission, it is used nationwide for local emergency services and every grade school child is taught how and when to use it. Nearly the same can be said for 411, which is also unassigned but so well known it pops up in song lyrics, and 511, which is assigned for traffic and transportation information and is found on traffic signs on highways across the nation. However, even though 311 is an assigned N11 code, it has not yet caught on. As of 2010, very few communities have the service up and running (Figure 7, left). In fact, when 311 is currently called from Cache County, the caller is connected with the 311 Customer Service Line for Provo, Utah, which is in a different county and is over two hours away from Logan by highway. The Provo 311 line also has a website associated with it where the user can search for information on their own (Figure 7, right). Efforts such as this seem like a good first step in helping the citizens to connect with the appropriate city or county staff member or information when they need non-emergency assistance. In addition, various tools and online applications for different services can be used in parallel with a website like Provo's 311 website (e.g., inundation maps for flood forecasting). Considering Brigham Young University is located in Provo and is involved with the NFIE and the Tethys Platform for web applications, a possible future goal should be to investigate combining services like the N11 codes, community customer service web pages like Provo's, and online tools for assisting in educating and preparing the nation's citizens.

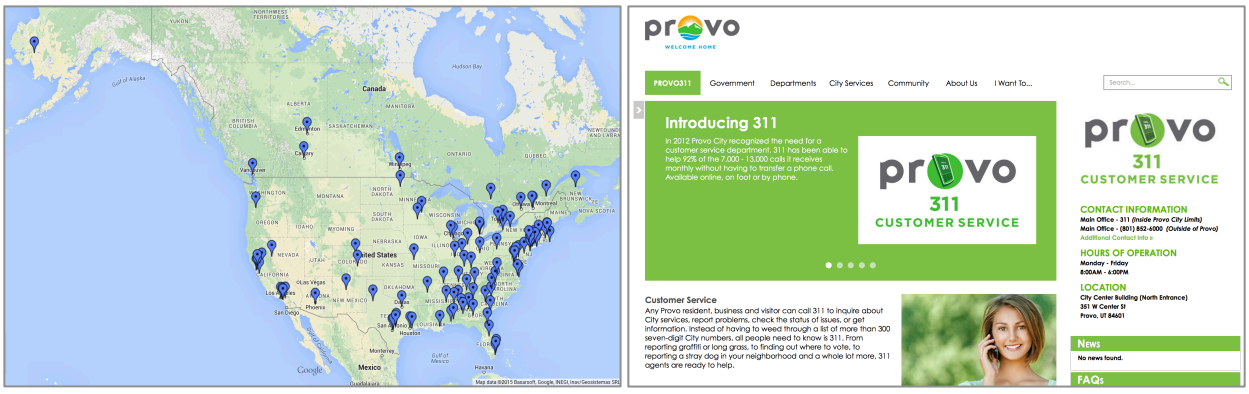

Figure 7: (Left) The nationwide use of the 311 abbreviated dialing code. [9] (Right) The 311 Customer Service website for Provo, Utah. [10]

Conclusion

The component of the NFIE that was investigated in this project was NFIE-Response. The planning and action phases were assessed through delineating vulnerable roads and infrastructure and assessment through a case study and discussion of possible future work. The purpose of the project was to become familiar with Cache County in preparation for the NFIE Summer Institute. The NFIE-Response database map was constructed, the local emergency response community was contacted, and a simple case study was performed. The original objective of assessing the strengths and weaknesses of the NFIE-Response database map for Cache County was not completed due to lack of interest and involvement of the local emergency response community. However, this lack of responsiveness along with questions that arose from the analysis of the case study resulted in a much-needed perspective on the local community. This newly gained perspective is the type of social science that must be taken into consideration when designing, planning, and implementing the nationwide NFIE-Response protocols. The 311 Customer Service line and website for Provo, Utah, are working examples of the type of planning and action some communities are already taking, which is in stark contrast to other communities, like Logan City and Cache County.

References

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