Developing A Global Positioning System (GPS) to Improve Emergency Response on the Tohono O'odham Nation

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Introduction

Rapid emergency response times can mean the difference between life and death. Getting to the scene quickly makes it more likely that medical responders can deliver emergency care to victims of falls, heart attacks, and strokes; police can intervene in violent disputes before they become lethal; and firefighters can rescue occupants before structures are consumed by flames.

The Tohono O'odham Nation (TON) faces many challenges to rapid emergency response times. Located in southern Arizona, the TON is very large and rural, encompassing 4,460 square miles of rugged Sonoran Desert. It has eleven political districts, nine of which are contiguous.[1] For most of the TON there are no formal addresses for homes nor are there street names within the communities. Therefore, there is no 911 addressing system for first responders to use during emergencies. Typically responders are given the name of the community to which they are responding and a series of physical landmarks coupled with characteristics of the home or location (colors, vehicles, mile markers, etc.). This can make it very difficult to locate homes, especially at night. It is not uncommon for responders to radio back to the dispatch office during a response because they are having difficulty finding a home within a community. This can potentially further delay an already lengthy response.[3] In some of the more rural areas, it can take an hour or more from the time a 911 emergency call is made until the responders arrive on-scene.

The purpose of this project was to see if response times could be improved by instituting a GPS-based emergency response system at one district of the TON.[2] Although GPS has been utilized in Indian Country for motor vehicle injury prevention,[3,4] we did not find any articles about its use to enhance emergency response in rural American Indian communities.

Methods

Background

The Tohono O'odham Nation Fire Department (TONFD) and Emergency Medical Services (EMS) are dispatched out of a central office in Sells, Arizona, capital of the TON. Indian Health Service (IHS) EMS responders provide services to the eastern districts of the TON. EMS responders for the town of Ajo, Arizona, cover the western districts. The Tohono O'odham Police Department (TOPD) is dispatched from an office in Sells that is geographically separate from the TONFD. Both the TONFD and Ajo EMS have several remote stations throughout the TON.

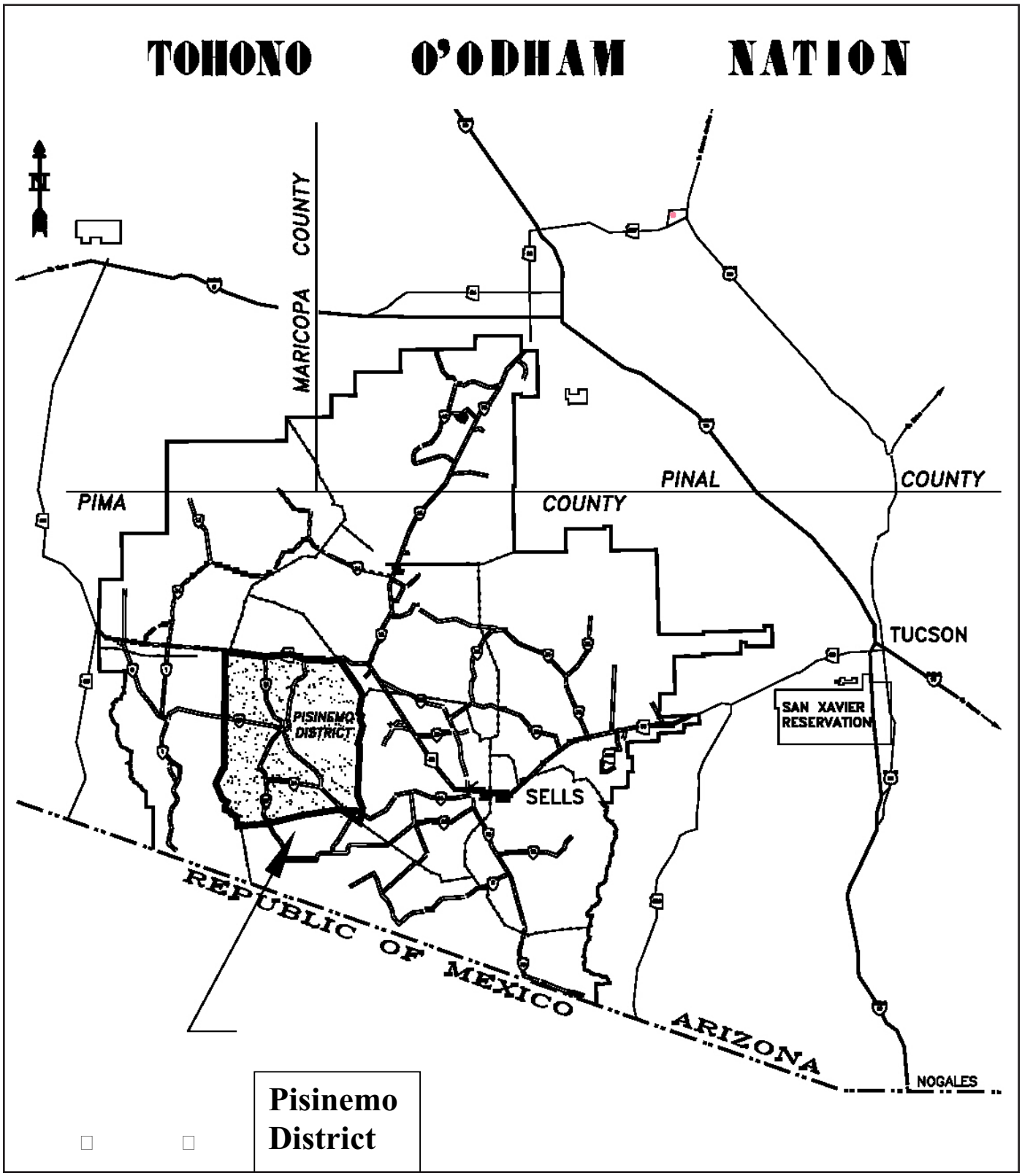
We obtained permission to publish this project from the Pisinemo District Chairperson and the national IHS IRB.

Design

We chose the Pisinemo District for this pilot project because we had the enthusiastic support of the District Chairman, TONFD Chief, and Ajo EMS Chief. All of the communities are served by a TONFD fire truck (E-233) and an Ajo EMS ambulance (M-43) based in the town of San Simon (Figure 1). Other ambulances respond to this district, but only when M-43 is out of service or otherwise not available. The TONFD Chief not only agreed to the project, but provided an Assistant Battalion Chief as a point of contact. The Chief of Ajo EMS also agreed to the use of a GPS device by personnel in ambulance M-43. We also obtained permission from the IHS EMS Chief, as his agency is in charge of the dispatch office for the entire TON (with the exception of the TOPD). He also allowed us to access all of the run logs to calculate pre- and post-intervention response times for the district. In addition to meeting with the District Chairman and other agency representatives, we presented at the local monthly community meetings. There we discussed the purpose and activities of our proposed project with residents of the District.

Our target population was any home in the Pisinemo district making a 911 call and receiving a response from either the fire truck or ambulance stationed in San Simon. To obtain GPS coordinates for each home, we met with the TON Housing Authority and the TON Utility Authority. Both entities had the GPS data, but were unable to share the information due to privacy and legal concerns. We were more successful with the Tucson Area IHS Division of Sanitation Facilities Construction (SFC) engineers. For each home on the TON, they had GPS coordinates located on a .kmz file within Google Earth. Each home had the homeowner's name attached to it or

Figure 1. Map of the Tohono O'odham Nation



was listed as "vacant." In obtaining the file for the Pisinemo district, the names and all personal information were removed.

We then assigned each home a number consisting of a community prefix and two-digit suffix (e.g., PS-2 or SC-6). A total of 236 homes (both occupied and vacant) were assigned numbers. With 143 homes, the community of Pisinemo was the largest of the seven communities in the Pisinemo district.

The GPS locations were then loaded onto handheld GPS units using a software program called "Expert GPS." "Expert GPS" automatically converted the Google Earth .kmz file with the home coordinates into the GPS format based on degrees, minutes, and seconds. The latter information was saved to a new ".gpx" file that could be transferred to the handheld GPS units. Two of these GPS units were provided to the San Simon station, one for the TONFD truck (E-233), and one for the Ajo EMS ambulance (M-43). Color printouts of an aerial view of the District showing all the homes and their assigned numbers from the Google Earth .kmz files were provided to responders at the San Simon station, the TONFD Assistant Battalion Chief, and the dispatchers in the Sells dispatch office.

We took several steps to ensure that each resident was aware of their assigned home number. We prepared a cover letter to residents explaining the project's purpose and methods. We provided two business card-sized magnets to each home with the home numbers written with permanent markers. These magnets could be placed on a refrigerator or in some other obvious location so the home owner could refer to it in case of an emergency. We also distributed highly-visible, fluorescent yellow, laminated sheets with each home's number in bright red marker. The sheets could be posted in a window or outside where they would be easily visible to responding personnel.

We visited every home in the Pisinemo District to deliver the letter, magnets, and sheets with home numbers. If the resident was at home, they were given the information and an explanation of the project. If the resident was not home, the materials were put in a large envelope and left on or inside their front door. In addition, the numbered yellow sheets were posted on each vacant house for firefighters or for other purposes where ease of location would be beneficial.

Data Collection

Each response on the TON for TONFD and EMS is hand written on a "run sheet" at the dispatch office in Sells. The dispatchers typically record four time elements for each response: (1) the dispatch time when they notify the responders a response is required, (2) the time when the responders indicate they are leaving the station, (3) the time when the responders arrive at the destination, and (4) the "in-service" time when the responders have completed the response and are available once again. For our purposes, "response time" was calculated as the difference between the times (2) and (3). The nine months of January 1 to September 31, 2011 were the baseline period and the four months between October 1, 2011, and January 31, 2012 were the intervention period.

After the intervention period, we conducted interviews with district representatives, the IHS dispatchers, and staff from the TON fire department and Ajo EMS service. These interviews focused on possible obstacles to full implementation of the project and levels of satisfaction with the GPS system.

Results

There were 133 runs made by M-43 (ambulance) and E-233 (fire truck) to the Pisinemo District during the baseline period. Of these, 89 runs were made by E-233 and 44 by M-43. All of the runs during the baseline period were to the communities of Pisinemo, San Simon, and Santa Cruz. There was one run to the community of Kupk that was omitted, as it was the only run to that community for the entire project timeline. During the intervention period, there were 62 runs made by M-43 and E-233: 40 runs by E-233 and 22 by M-43. Ajo EMS ambulances other than M-43 made 31 runs to the Pisinemo District during the baseline period and 13 runs during the intervention. Response times for these runs were excluded from our analysis because these other ambulance had not been provided with GPS devices.

The average response time for the combined ambulance and fire truck runs during the baseline period was 16.8 minutes and 13.9 minutes during the intervention period (Figure 2). This result was statistically significant at the 0.05 level (2-tailed, unpaired, t-test, t = 2.33). Table 1 demonstrates that response times varied by community, responder (ambulance or fire truck), and period (baseline vs. intervention). San Simon showed no difference in average response times. For Santa Cruz, fire truck response times actually increased slightly (by half a minute). The 7.7 minute decline for ambulance response to the Santa Cruz community was based on a single run during the intervention period.

Discussion

The 3-minute decline in overall average response time, although statistically significant, was a modest one. One reason was that the pilot system was not used to its full potential.

Figure 2. Average Overall Response Times (minutes)

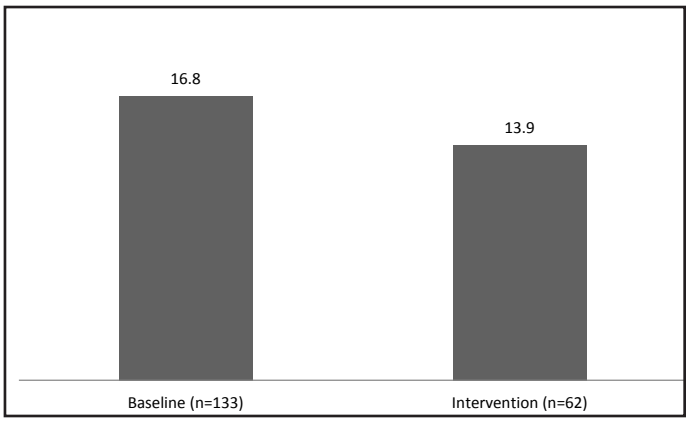


Table 1. Average response times by community and responder in minutes.

District Responder	Baseline	Intervention	Difference
Pisinemo			
Fire E-233	20.2 (n=62)	18.3 (n=21)	-1.9
EMS M-43	17 (n-28)	16.5 (n-11)	-0.5
San Simon			
Fire	6.4 (n=18)	6.4 (n=14)	0
EMS	6.3 (n=13)	6.3 (n=10)	0
Santa Cruz			
Fire	24.7 (n=9)	25.2 (n=5)	+0.5
EMS	24.7 (n=3)	17 (n-1)	-7.7

There were instances where homeowners failed to report their house numbers, the numbers were not relayed to the responders by the dispatchers, or the responders did not use the GPS devices. Both Ajo EMS and TONFD work on a rotational schedule; important information was not always relayed to new personnel. The GPS devices themselves proved to be a limitation. The hand-held units required time to track satellites when turned on. This made it difficult for the responders to use them during the short runs to San Simon. The devices need a clear line-of-sight to function, requiring the responders to hold them near a window in the vehicle while driving to the scene. Detailed analysis by responder and community was limited by small sample sizes. Finally, we did not control for other factors that contribute to response times and which may have varied between baseline and intervention periods. These include time of day (night vs. day), nature and urgency of the call, and weather conditions.[5]

Among the unanticipated consequences of this project were the value of the aerial maps and the use of the GPS coordinates for non-emergency purposes. On several occasions, the dispatchers used the hard copy aerial maps with the home numbers to help the responders locate homes. I used the handheld GPS unit to quickly and accurately locate a home in San Simon for an environmental health visit. Other agencies and services on the TON, such as public health nurses and Community Health Representatives, can expedite their home visits using the home numbering and GPS system.

At a Pisinemo District meeting in March, 2012, residents stated that they are using the home numbers and would like to continue to do so. The TONFD now has laptops in each of their fire engines and will likely purchase GPS software for them. Expanding the enhanced emergency response system throughout the Tohono O'odham Nation will require additional funding, training, and strategic planning. Most importantly, it will require collaboration among numerous agencies, including EMS, fire, police, and the TON Office of Emergency Management.

References

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Acknowledgements

For all their encouragement and support, I am very grateful to Dr. Larry Berger, CDR Don Williams, CDR Shari Windt, and LT Angela Hodge, Tucson Area Indian Health Service, Tohono O'odham Nation Fire Department Assistant Battalion Chief Joe Soqui, Sells EMS Supervisor Mark Adams, Ajo EMS Supervisor Lonnie Guthrie, Sells IHS Dispatcher Carlina Lopez, Pisinemo District Chairman Mr. Stanley Cruz and, most importantly, the residents of the Pisinemo District, Tohono O'odham Nation.