Participatory Mapping
for Disaster Preparedness:
The Development & Standardization of
Animal Evacuation Maps

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ABSTRACT

People who own animals are faced with complex decision making in evacuations. In the US, the Emergency Operations Center is often inundated with calls from animal owners who are aware they are under pre- or mandatory evacuation, but are unsure of what to do about evacuating their animals. Often animal evacuation is a highly improvised activity for owners and responders, though there is a now a general push toward streamlining procedures because of the high impact the matter of animals has on society's welfare during times of emergency. This paper reports on the use of participatory design methods in a mapping project to support the range of people involved in animal evacuation during mass displacement events. The work provides insight into both procedures and standards for creating evacuation maps that communicate clearly with the public and across the range of emergency responders.

Keywords

Animals, crisis informatics, emergency management, evacuation, maps, participatory design, social media

INTRODUCTION

Animals play a vital role in the lives of humans. For many, companion and service animals are members of the family, while for farmers, livestock are critical to their livelihoods. The loss of animals during the UK mad-cow disease crisis demonstrated how economically and psychological devastating the loss can be to farmers (Hagar and Haythornthwaite, 2005), yet the plight of animals in disaster often goes unreported. For example, though there were "no deaths" reported in the Christchurch, New Zealand earthquake of September 2010, more than 3,000 animals were killed, which mainly impacted farmers (Glassey & Wilson, 2011). Research shows that people take into account a number of factors in evacuations (Dynes, 1983; Quarantelli, 1980, 1990), and the matter of their animals is a significant one that informs decisions. For animal owners, the decision of how to evacuate, where to go, when to go, and so on, is complicated by the human-animal bond (Hunt, Bogue, Rohrbaugh, 2012; Irvine, 2004, 2009).

In the US, the PETS Act of 2006 alleviated some of the problems of human-pet evacuation. It came about after the devastating effects of the 2005 hurricane season in the US, when many people failed to evacuate because their pets were not allowed on public transport or to enter shelters. For those who did, upwards of 70,000 pets were separated from their families and euthanized or left to die. The PETS Act enables people to evacuate with their companion and service animals on public transportation. It also provides financial support for animal shelters in affected regions (Leonard & Scammon, 2007; Mike, Mike & Lee, 2011). The PETS Act, however, does not have contingencies for large animals.

Still, even with the PETS Act in place, people may delay evacuating, or not evacuate at all out of concern for their animals. Challenges in transporting animals, especially if they do not easily fall within the scope of "companion and service animals" that the PETS Act covers, increases the burden on animal owners who may

have to seek outside support (for example, see White, Palen & Anderson, 2014), and this may further delay evacuation, or even lead to evacuation failure.

For people who own animals in Colorado, where the work reported in this paper was conducted, it is common for the county's local fairgrounds to receive animals during a disaster evacuation, with wildfire being the most common mass evacuation hazard in the region. When such evacuations happen, the work is tremendous as animals, people, and equipment converge onto fairgrounds that have been hastily converted into shelters for a range of large and small animals under stressful and usually high-temperature conditions. Once there, owners often leave their animals behind and trust that they will be monitored and cared for. Teams of trained volunteer animal responders known as Community Animal Response Teams (CARTs) manage the animals on-site at the fairgrounds. They also often provide logistical support for those needing assistance in moving their animals, and care for animals displaced from their owners (PetAID Disaster Services, n.d.).

The focus of this project is to streamline this important activity and create information resources that are helpful to emergency management personnel, CART volunteers, and animal owners. Specifically, we report on a participatory design activity that created easy-to-use maps that support the complicated logistics of a large-scale animal evacuation. The paper reports on how computer science students and emergency responders (both professional and volunteer) created standards (including map symbols, layout, and messaging) for use in animal evacuation. We discuss how a team of students and practitioners created and deployed fairgrounds evacuation maps for two counties in Colorado, including lessons learned around matters of map development and community engagement. The resources we created—map symbols and a checklist field guide resource —are made available to the reader so that other regions might do the same.

BACKGROUND: MAPS FOR ANIMAL EVACUATION

Because convergence onto fairground sites means that people come from near and far, the logistics are complicated, and there are few maps to instruct people what to do once there. Fairground maps are often generic maps that show only the physical features of the land (buildings and fields), and are not tailored to the multi-animal use of an emergency animal shelter. They do not provide information about how the shelter will be *used* for the evacuation. This complicates the organization of the effort and therefore the instructions to the public because of insufficient intersubjective awareness about what needs to be done. The lack of intersubjective awareness limits the extent to which some of the coordinating work of getting animals on-site can be decentralized to those owners who are bringing them with trailers and trucks.

Fairground sites are geographically large spaces with a range of infrastructure. Though many members of the public may have attended their local fairgrounds in normal times, the way the sites are set up in animal evacuation mode is different. Animals may be sheltered in different locations, even in temporary pens. Flows of traffic may be restricted, and security requirements may see visitors to the site need to complete sign-in procedures and other paperwork. Arrangements over the course of the evacuation period could also change, with animals being moved on-site as new animals arrive and as the CART reassesses its resources. The lack of a *shared* map resource reflecting the current state of the site leads to misunderstandings, and thus likely misinforms action (Dymon & Winter, 1991).

Research on the use of maps in emergency has included the societal impacts of mapping hazards (Monmonier, 1997; Dymon & Winter, 1991; Dymon 2003), and recent work has explored the pervasiveness of social technology and the use of crowd involvement to create maps in crisis (eg, Liu & Ziemke, 2013). The socially constructed meaning of maps is also important. For example, Henderson (2013) invited Hurricane Katrina survivors to render cognitive maps after the disaster, highlighting how people nevertheless have multiple contextual understandings of space. The availability of open data mapping tools (Soden & Palen, 2014), specifically OpenStreetMap, invite new thinking about co-creation of maps of land use for critical situations that have short temporal durations—maps that impose meaning on how features like buildings, fields, arenas, and parking lots are to be used for a specific situation, and in this case, animal evacuation.

Dynes (1994) states that "the goal of emergency planning is to anticipate courses of action based on projected problems and possible solutions." With this and the previously referenced literature as our foundation, we envision how the creation of maps of locations *in evacuation mode* using social technologies in collaboration with officials and volunteers could produce a valuable resource.

Using Participatory Design to Leverage Expertise

To create these maps calls upon more than local knowledge or an ability to use digital tools, though these are of course necessary. The creation of useful maps that make visible how the physical infrastructure is assigned and how the traffic must flow during a high-convergence evacuation depends upon the expertise of those in working with animals at such sites. We note those working with animals at these locations are often aligned with multiple different agencies, who may only come together for exercises or call-out responses. Participatory design (Greenbaum & Kyng, 1991; Muller & Druin, 2012) with a community mapping influence (Amsden & VanWynsberghe, 2005) incorporates multiple stakeholder voices to best reflect how maps should appear and what they should include, while concurrently supporting community development through the engagement around the task.

THE MAPPING PROJECT

To support the demands of creating such a map, we included students experienced with using digital tools and who were invested in supporting a community project, as well as people who were experienced in fairgrounds use in evacuation operations. None of those involved were formally trained as designers. Instead, we used participatory design techniques to ensure good and accurate design, and to give the stakeholders ownership of the resource creation, so that it might be then be adopted, distributed, and used (Schular & Namioka, 1993; Muller & Druin, 2012).

The goals of the project were to:

   a.   Provide a map that efficiently presents information to the public to help in their decision-making for evacuating with their animals, both small and large;
   b.   Improve the coordination and flows of traffic in accessing fairgrounds sites;
   c.   Provide the people who work at and with animal evacuation sites (e.g., CARTs, Animal Control, Directors of Emergency Management and fairgrounds staff) with the opportunity to include the aspects they most wanted people converging to the fairgrounds to understand; and
   d.   Provide CART members with a relationship-building opportunity beyond the temporal-spatial confines of a disaster deployment, along with ownership of the resource they produced.

Execution

The project was conducted over five weeks in Spring 2014. Eleven students in the Social Computing course at the University of Colorado Boulder launched the project as part of their course capstone work. In this reporting we refer to the computer science student participants as "student designers." We invited a selection of subject matter experts (SMEs) who are active in the operation of two fairground sites when in an evacuation mode, and so who themselves are also stakeholders (and we use the terms interchangeably here). The SMEs were CART members, fairground managers, local animal control and emergency management officials at county and state levels. In Elbert County three stakeholders were able to participate in the on-site mapping session, and in Jefferson County, six stakeholders participated.

The student designers divided into two teams, with six students working with stakeholders at Elbert County Fairgrounds and five students working with stakeholders at Jefferson County Fairgrounds. The first author arranged the access and coached the teams.

Elbert County Fairgrounds

The first author is a CART team member and worked at Elbert County Fairgrounds through the Black Forest Fire event in 2013. She saw the problems of evacuation logistics first-hand, and she has built a strong relationship with those animal and emergency managers, giving her the opportunity to propose this project to them. Elbert County Fairgrounds is located in a rural area in Southern Colorado. The location has multiple points of access and limited lines of sight. It is well known by local residents, who visit the Fairgrounds for recreational activities such as rodeos. The Fairgrounds Manager supplied us with the map of the facility (Figure 1), which gives basic information about structures, their location on-site and their size.

Jefferson County Fairgrounds

Jefferson County Fairgrounds is located along the Front Range in Northern Colorado. The CART for the county is recognized as being a leader in its procedures, an important reason the project was conducted there. The Fairgrounds Manager supplied us with a map of the facility, which, similar to the map of Elbert County Fairgrounds, identifies the locations of structures and areas of general use.

Both sites have been put into operation multiple times in recent years as animal evacuation sites. An important benefit of conducting the project at two sites with different stakeholders helped scaffold joint work, and helps make the results more generalizable for other fairgrounds beyond this project.
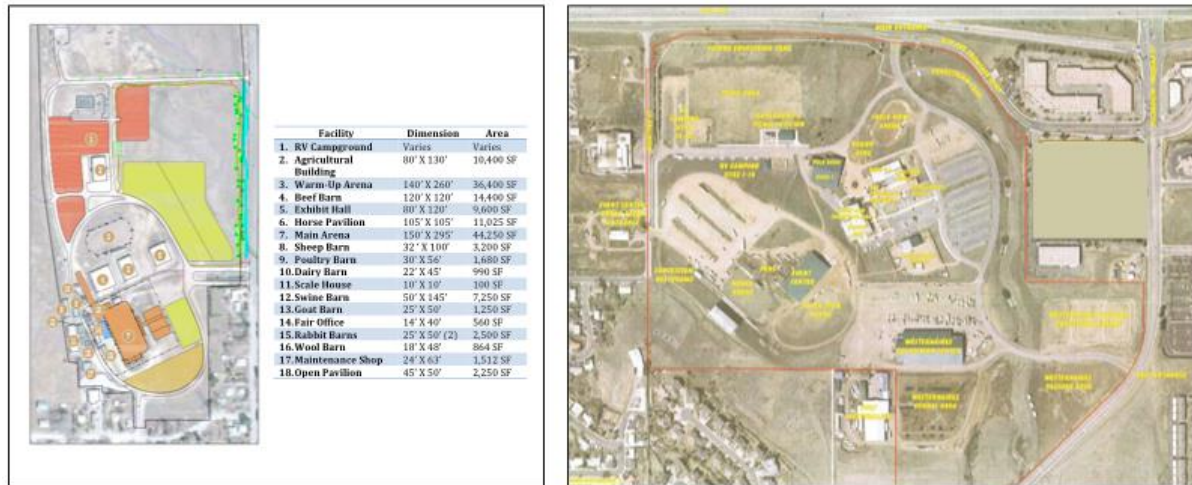

Figure 1: Existing Maps for Elbert County Fairgrounds (left) and Jefferson County Fairgrounds (right)

Preparing to Map

We scheduled the project to be completed within a five-week period as described in Table 1.

Week	Activity
1	*Student designers:* Literature review on animals in disaster, CART operations, participatory design methods and evacuation and purpose-built maps. *Stakeholders:* Briefing on the goals of the project, to provide an information resource they might find useful in communicating to the public in evacuations.
2	*Student designers:* Use OpenStreetMap to create a base layer of infrastructure and roads for the fairgrounds sites. Export these maps to Walking Papers. Identify questions to ask to assist with knowing what needs to be mapped, and what does not, and send to stakeholders before on-site mapping session. *Stakeholders:* Review student designer questions in preparation for mapping session. Gather any existing maps and information to assist the process. At the end of the week, hold the on-site mapping session.
3	*Student designers:* Transfer information from field papers into a new map design that reflects the site in animal evacuation mode. Create map symbols as appropriate. Email maps to stakeholders for feedback. *Stakeholders:* Review maps, and provide feedback to students via email. Detail elements that need adjustment, addition or deletion.
4	*Student designers:* Incorporate stakeholder feedback. Create second iteration of maps. *Stakeholders:* Provide student teams with preferred means and format for receipt of the maps – digital, paper, etc.
5	*Student designers:* Deliver final maps to stakeholders in preferred formats.

Table 1: Community Mapping Project Schedule

The student designers were knowledgeable in the use of technology, but had no experience of disaster management. To prepare them for this project, we supplied readings about animal management in disasters

(Glassey & Wilson, 2011; Irvine, 2004; PetAID Disaster Services, n.d.; SandyCity UT 2013), and map design techniques (Amsden & VanWynsberghe, 2005; Dymon, 2003; Dymon & Winter, 1991; Parker, 2006). We discussed the kinds of information challenges the stakeholders and the public have in evacuating their animals. We also described the roles of each of the stakeholders.

The two student teams scheduled co-located and simultaneous weekly meetings, which allowed collaborations across teams. We used an enterprise social networking site, Yammer, for sharing design documents as well as to support ongoing communication outside the meeting times and field trips, and to organize and track the work.

Development of Questions to Guide the Mapping Session

After completing the background reading, and in preparation for the on-site mapping session, students posted questions to a shared Google document. During Week 2, we reviewed the questions, and answered those we could based on our own in-field and disaster experience. Expecting that many more questions would become apparent once in the field, we reworked the remaining questions to serve as a semi-structured guide for interaction with the stakeholders. We grouped the questions into three categories: Infrastructure, Resources and Traffic Flows (Table 2). We distributed this set of questions to each of the stakeholders via email two days prior to the mapping session.

1	INFRASTRUCTURE
1.1	What are the main check in/out places?
1.2	Which animals go in which location?
1.3	Do you have a location for animals that 'do not play well with others?'
1.4	Where are the temporary structures located? (Emergency Operations Center, temporary pens, anything else relevant?) Would you like these on the map in some way?
1.5	Is there a difference in the setup for different evacuations? (We want the map to be useful in most circumstances. We want to talk about the best way of doing that.)
1.6	Human toilets - Which would you like the public/volunteers to use?
2	RESOURCES
2.1	Feed - Where is it stored? Different types?
2.2	Water - Where are the main water access points?
2.3	Electricity - Where are the main outlets?
2.4	Information – Where do people with animals on site access information?
2.5	Donation control - What donation information is desired on the map, with a drop off location?
3	TRAFFIC FLOW
3.1	How do you want people to access the Fairgrounds? Is it different depending upon: a. What type of animal they are bringing in? b .Volume of traffic eg. During demobilization?
3.2	Where do you want people to park?
3.3	Would you want the animal intake/release process noted on the map?

Table 2: Sensitizing Questions for the Mapping Session

Creation of the "Base Layer" Map and "Field Papers"

The two teams of student designers used OpenStreetMap (OSM) to outline the fairground sites, including built infrastructure and roads. This created a base layer of the sites. When the outlines were done, the teams then exported the OSM maps to a service called Walking Papers (http://walking-papers.org). Walking Papers allowed us to create a printout of the selected area, divided into segments that could be easily printed and then annotated with pen. We decided that each of the students should have their own set of field papers so that there were multiple records of data from the mapping session, which would then provide confirmation for the location of elements to be mapped for each site. Figure 2 shows the field papers generated for Elbert County Fairgrounds.

Mapping Session

The student designers and stakeholders gathered at each site (a few days apart) for a two-hour mapping session. We provided name tags and an overview of the plan for the session. We shared the existing maps of the site and printed sensitizing questions to help guide the collaboration.

Identifying What to Map

We spent the first hour in conversation guided by the questions. The stakeholders shared their experiences with respect to site management with a high level of detail about their work and what they wished could be supported by a good map, reflecting the experiences of Elovaara and Mörtberg in their cartographic mapping work (2010). As the stakeholders described their work practices, the sensitizing questions became more of a reflective checklist to ensure the team covered everything. Numerous times the students needed to clarify aspects of where the particulars of evacuation work happened, leading to detailed conversations about such things as animal check-in procedures. At Jefferson County we realized a good amount of the evacuation work happened in small location on the Fairgrounds. This problem area became a focus for the mapping task.

Furthermore, this discussion provided a depth of detail that then created opportunities for the stakeholders to reconsider *in the moment* inefficiencies in their work, with new solutions being built right into the new map. This orientation moved the stakeholders from "what had been" and "taken-for-granted assumptions" to a forward-thinking collaboration around what could be made better (Madison, 2005).

At Elbert County, one of the stakeholders said she had been disappointed in the last major evacuation, the 2013 Black Forest Fire event, when people converged onto the site using the main entrance, which could have led to blockages on the main road. She suggested that a northern entry would be better. Another suggested the inclusion of an area for media staging. Other additions included the location for Incident Command and the Salvation Army food truck, both of which have assigned locations during evacuations but, because they are not permanent fixtures, are not noted on any maps. Additionally, some locations onsite were renamed on the map for this evacuation context. For example, the "Scale House" was renamed the "Small Animals Check-in."

During the first hour at Jefferson County Fairgrounds, the Fairgrounds Manager explained that recent work on-site meant that one internal road was now wide enough to accommodate trailers traveling both towards *and* away from the area the CART had designated for large animal drop-off. The CART members discussed this and decided to adjust the planned traffic flows based on this new information.

These illustrations show how participatory design enabled the stakeholders to negotiate with each other about what was important to have for an evacuation map—or not. They needed to articulate features of their work that were not necessarily known to all others. Information they wanted the public to know was as important as the information they did not want to share, such as the locations of electrical outlets (deemed a security risk) and toilets (so the public would not have access to all parts of the site). The stakeholders recognized the limitations these decisions imposed on the maps, rendering them less useful for workers on-site.

The Jefferson County stakeholders determined that their animal response team was established and familiar enough with the Fairgrounds in an evacuation context that they would only need a single map for public use. On the other hand, after going through the same process at Elbert County Fairgrounds, the stakeholders there determined they needed two maps; one for the public, and one for workers.
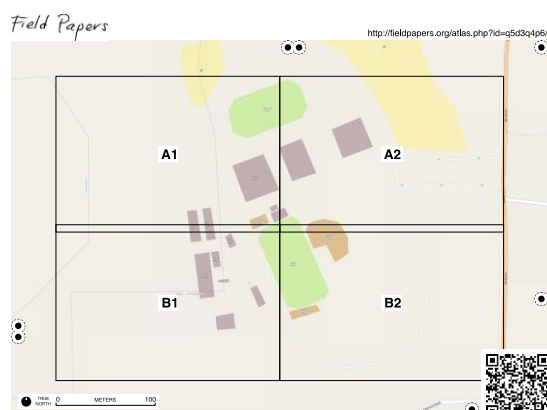

Figure 2:
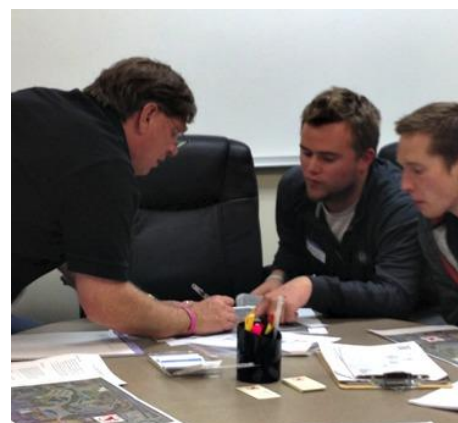**Field Papers for Elbert County Fairgrounds**

Figure 3:
Stakeholder Working with Student Designers

Walking the Traffic Flow of Evacuation

Everyone then walked the fairgrounds site together, following the flow of traffic routes they had identified. We

had originally thought this would be done in pairs or threes, however one stakeholder at Elbert County suggested the group walk together so that collaboration could continue if new questions arose. As we walked together, the stakeholders continued to share some experiences from previous evacuations, which built on the general information the students already knew about animals in disaster. For example, they shared the story of one evacuee who had arrived in the early hours of the morning, with her car holding a number of small animals, including chickens and dogs. Distressed, the evacuee had had to leave her two horses behind as she did not have a trailer large enough to evacuate them. By lucky coincidence, a local responder passed the horses a few hours later with a large enough trailer to collect them, and by mid-morning the evacuee and all her animals were reunited at the Fairgrounds.

While walking the routes, the stakeholders pointed out the infrastructure and other elements they had described earlier, so we could better understand the way the site would "look" during an evacuation. The students made notes on their field papers and took photographs. The mapping sessions were each completed within two hours.

Development of Map Designs

In the few days following the on-site work, both teams of student designers consolidated their field papers and photographs so they could create the first maps. When they were complete (Figure 4), we sent them to the stakeholders by email to obtain feedback.
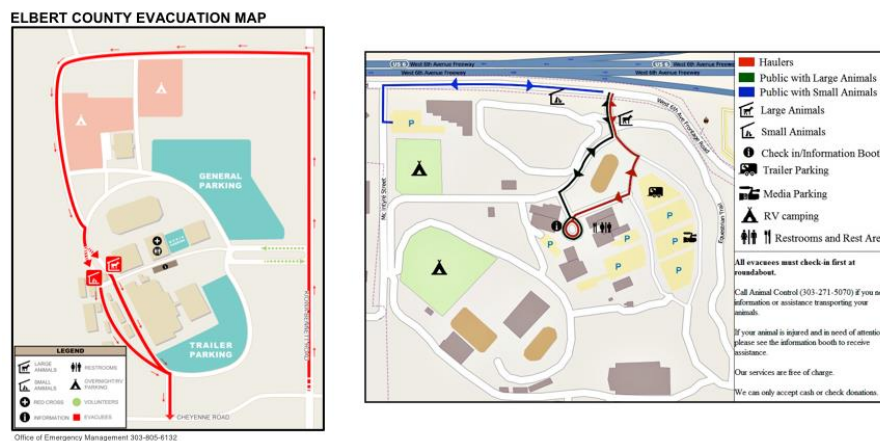

Figure 4: Examples of First Maps for Elbert County (left) and Jefferson County Fairgrounds (right)

Using Stakeholder Feedback to Iterate Map Designs

Most feedback across both sites concerned the labeling of different locations and infrastructure. Stakeholders at Jefferson County decided to remove some labeling of infrastructure, saying they needed flexibility for structural use depending upon the type and needs of an evacuation. In addition, word selection became a focus at this stage. On the mapping day, the stakeholders had used the term "haulers" to refer to their own large animal transport, but but realized upon printing the map that this could be confusing to the public (Figure 4, right). They decided to clarify by renaming it "private haulers" (Figure 6). Similar design alterations were requested by Elbert County, such as adjusting the shape of the main ring.

In the process of emailing their feedback to us, the stakeholders for Jefferson County continued to ask questions of each other, to clarify flows of work in areas they were unfamiliar with. For example, one stakeholder asked the site's Fairground Manager;

> *"Does the Fairgrounds also allow for tent camping if necessary – or at least in an emergency? Or is it only RVs all the time?"*

…to which the Fairgrounds Manager responded:

> *"Normally we have limited tent camping sites, but in times of emergency, we have the flexibility to allocate additional space for camping. Communication is critical during these times."*

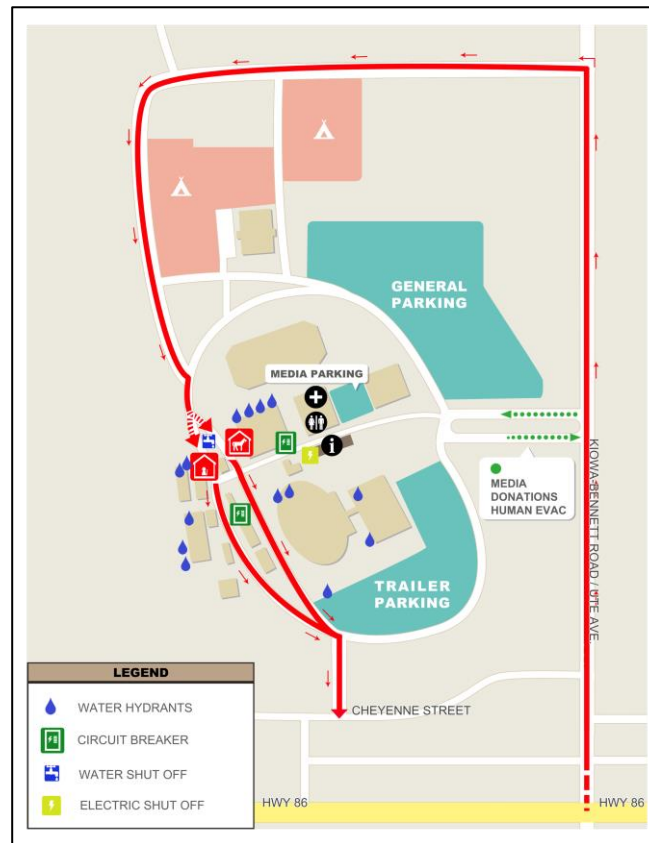The students iterated the designs, and by Week 4 they had produced the final maps (Figures 5 and 6).

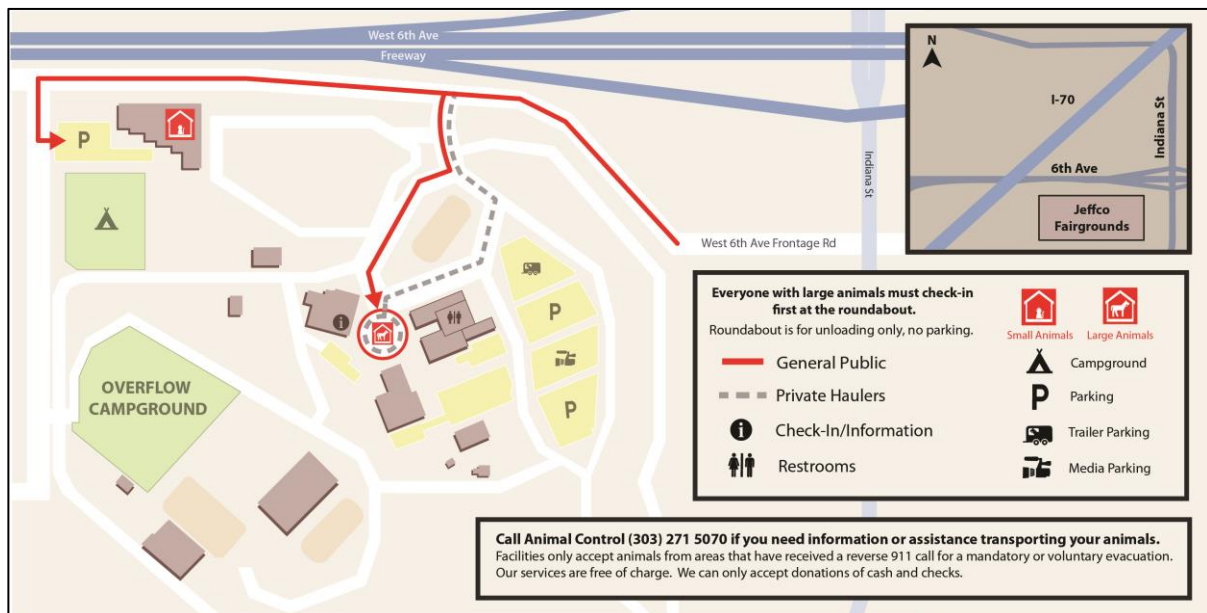**Figure 5: Final map for volunteers at Elbert County Fairgrounds**

Figure 6: Final public map of Jefferson County Fairgrounds

EXPERIENCES

Our experiences are reported in two sections reflecting the goals of the project: First, to design maps for the public to improve coordination and flows at animal evacuation sites; and second, to provide stakeholders with a relationship-building opportunity through map creation.

Designing Maps for the Public to Improve Coordination and Flows at Animal Evacuation Sites

Stakeholders at both locations approached the mapping project with the belief it would be of use to constituents, and that the resulting maps would improve coordination. The student designers took on the technical load of producing the maps while the stakeholders focused on the elements the maps should include.

Maps as Efficient Information Resources

The progressive question and answer work before the mapping began, and then working on-site with stakeholders meant that the team could together filter meaningful detail from otherwise vast experience. The level of detail on the maps needs to support efficient communication for precise, safety-critical and fairly time-critical work. Detail in the maps was focused on foregrounding the infrastructure and routes to enable efficient movement to and within evacuation sites, eliminating the gridlock that can occur when large vehicles and trailers traverse narrow roads. The decisions about what to include in maps are challenging. Schmidt (1998) has said, "the gist of design work can be said to consist of exploring and identifying the interactions between conflicting requirements so as to be able to decide on an acceptable compromise," and this was true of this project's experience. The teams at each site appreciated that the maps needed to contain *just enough* information (Brown and Duguid, 2002), to help the public quickly understand what was expected at the sites. These collaborative decisions led to maps with clear and simple information.

In addition, the stakeholders joined in on the project with the full intention that the maps would be used. Jefferson County features its map on its website and emergency blog (http://jeffcosheriff.blogspot.com/p/blog-page.html). They report, "The map is simple, clear and easy to understand and will give people—even those under duress—the ability to safely and quickly navigate to a safe haven for their animals." The Elbert County map will be deployed by the Public Information Officer in the event of an evacuation.

Using Standardized Map Symbols

Research shows that it is preferable to use standardized symbols in map creation (Akella, 2009; Robinson, Roth and MacEachren, 2010; World Humanitarian and Country Icons 2012). Wherever possible, we aimed to use standardized symbols common to emergency maps, however we were unable to find symbols that were particular to animal evacuation. We created two symbols as part of this project, one to symbolize the sheltering of small animals, and one for large animals (Figure 7). Both symbols were developed through iteration with the stakeholders along with the maps.

We submitted the two symbols to The Noun Project, an open source international symbol repository. They are now included in its crisis symbol collection for humanitarian open mapping use around the world.
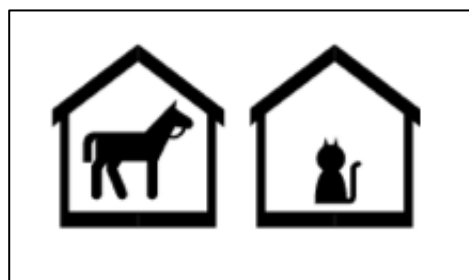

Figure 7: Large and Small Animal Shelter Symbols. These symbols are now publicly available through The Noun Project.

Providing Stakeholders with a Relationship-Building Opportunity Through Map Creation

The mapping project included CART members, officials and other stakeholders such as fairgrounds managers, who may not otherwise have had input to the processes and flows of work at these animal evacuation sites, even though they have an interest in how the sites are put into operation. During the mapping session (and for those at Jefferson County, continuing through subsequent email communication), the stakeholders saw opportunities to adjust their previously established plans and worked together to suggest and make changes.

The decision to use participatory design techniques involving a cross-section of stakeholders also invoked challenges. It was common for stakeholders to hold different views on what the maps should include. However, it was the stakeholders' differences that made this a rich experience, for it was in the process of the mapping that

different perspectives were revealed, adjustments and compromises made, and consensus discovered *between the stakeholders themselves*. Future implementations might also include animal owners as part of the design exercise, to gain insights from those not familiar with a location in evacuation mode.

Bonding through Sharing Stories

Throughout the mapping effort, stakeholders shared evacuation stories. The experience of emergency response is unusual, even for those who are regularly engaged with it, and sharing stories provided personal and professional connection between all participants. One of the newly hired emergency managers (who is in charge of all aspects of disaster, and was learning about the details of animal evacuation) shared that the mapping session provided useful information that would not have been available another way, saying, "I had heard lots about it, but I had no idea how big an operation it was until I walked it with you all."

Dissemination

The project effort concluded with a final formal presentation of the maps to all the stakeholders, as well as State representatives who oversee animal evacuation and sheltering. Their goal is to make maps based on the decisions that came about through this effort for fairgrounds across the State. In addition to the guidelines supplied in this paper, we have compiled a field guide checklist resource to support communities that wish to implement the project with their own teams. These are accessible at <http://www.cs.colorado.edu/~palen/AnimalEvacuationMaterials>.

CONCLUSION

This paper reports on a participatory design activity conducted with stakeholders at two county fairgrounds in Colorado. The project was aimed at supporting the needs of the public and of CART teams to provide efficient and accurate information about animal evacuation through easy-to-use, customized-to-evacuation maps. The project allowed stakeholders to review their animal evacuation and sheltering procedures and collaborate on an activity beyond the scope of their usual training or deployment operations.

As researchers, we saw this project as an opportunity to learn more about how emergency responders work together, and how they might be able to better communicate information to the public in ways that can support effective decision making in evacuation. In addition to the creation of maps for each fairgrounds site, this project provided both stakeholders and researchers with valuable insight about the ways responders can prepare themselves and the public for animal evacuation. This mapping project is a low-cost, relationship-building activity that we believe emergency responders can operationalize with their communities.

ACKNOWLEDGMENTS

REFERENCES

1. Akella, M. K. (2009). First responders and crisis map symbols: Clarifying communication. *Cartography and Geographic Information Science*, 36, 1, 19-28.

2. Amsden, J., and VanWynsberghe, R. (2005) Community mapping as a research tool with youth. *Action Research*, 3, 4, 357-381.

3. Brown, J. S., and Duguid, P. (2002). *The social life of information*. Harvard Business Press.

4. Dymon, U. J. (2003) An analysis of emergency map symbology. *International Journal of Emergency Management*, 1, 3, 227-237.

5. Dymon, U. J., and Winter, N. L. (1991) Emergency mapping in grassroots America: A derailment evacuation case study. *Geoforum*, 22, 4, 377-389.

6. Dynes, R. R. (1983) Problems in emergency planning. *Energy*, 8, 8, 653-660.

7. Dynes, R. R. (1994). Disastrous assumptions about community disasters. Disaster Research Center. University

of Delaware.

8. Elovaara, P., and Mörtberg, C. (2010, November) Cartographic mappings: participative methods. In *Proceedings of the 11th Biennial Participatory Design Conference*, 171-174.

9. Glassey, S., and Wilson, T. M. (2011). Animal welfare impact following the 4 September 2010 Canterbury (Darfield) earthquake. *Australasian Journal of Disaster and Trauma Studies*, 2011-2.

10. Greenbaum, J. and Kyng, M. (1991) Design at work: Cooperative design of computer systems. Hillsdale, NJ: Lawrence Erlbaum Associates.

11. Hagar C., and Haythornthwaite, C. (2005) Crisis, Farming & Community. *The Journal of Community Informatics*, 1, 3, 41-52.

12. Henderson, K. (2013). Mind maps, memory and relocation after Hurricane Katrina. *Dynamics of Disaster: Lessons on Risk, Response and Recovery*, 77.

13. Hunt, M. G., Bogue, K., & Rohrbaugh, N. (2012) Pet ownership and evacuation prior to Hurricane Irene. *Animals*, 2, 4, 529-539.

14. Irvine, L. (2004) Providing for pets during disasters: An exploratory study. Natural Hazards Center. Retrieved from http://www.colorado.edu/hazards/research/qr/qr171/qr171.pdf.

15. Irvine, L. (2009) *Filling the ark: Animal welfare in disasters (Animals and Ethics)*. Temple University Press: Philadelphia, PA, USA.

16. Leonard, H. A., and Scammon, D. L. (2007) No pet left behind: Accommodating pets in emergency planning. *Journal of Public Policy & Marketing*, 26,1, 49-53.

17. Liu, S., and Ziemke, J. (2013). From cultures of participation to the rise of crisis mapping in a networked world. *The participatory cultures handbook*, 185-196.

18. Madison, D. S. (2011). *Critical ethnography: Method, ethics, and performance*. Sage.

19. Mike, M., Mike, R., & Lee, C. (2011) Katrina's animal legacy: The PETS Act. *Journal of Animal Law and Ethics*, 4, 1, 133-160.

20. Monmonier, Mark. *Cartographies of danger: Mapping hazards in America*. University of Chicago Press, 1997.

21. Muller, M. J. and Druin (2012) Participatory design: The third space of HCI. *Human-computer interaction handbook,* (Ed) J. Jacko. CRC Press.

22. Parker, B. (2006) Constructing community through maps? Power and praxis in community mapping. *The Professional Geographer*, 58, 4, 470-484.

23. PetAID Disaster Services (n.d.) Disaster relief for animals in Colorado. Retrieved from http://www.petaidcolorado.org/?DisasterServices.

24. Quarantelli, E. L. (1980) Evacuation behavior and problems: Findings and implications from the research literature. Disaster Research Center, Ohio University.

25. Quarantelli, E. L. (1990) The warning process and evacuation behavior: The research evidence. Disaster Research Center. University of Delaware.

26. Robinson, A. C., Roth, R. E., and MacEachren, A. M. (2010, May) Challenges for map symbol standardization in crisis management. In *Proceedings of the 7th International ISCRAM Conference–Seattle* (Vol. 1).

27. SandyCityUT (2013) CART – Community Animal Response Team. Informational video. Accessed at https://www.youtube.com/watch?v=SK6BM2yCjTY.

28. Schmidt, K. (1998). Cooperative design: Prospects for CSCW in design. *Revue sciences et techniques de la conception*, 6, 5-18.

29. Schuler, D., and Namioka, A. (1993) Participatory design: Principles and practices. L. Erlbaum Associates Inc.

30. Soden, R. and Palen, L. (2014) From crowdsourced mapping to community mapping: The post-earthquake work of OpenStreetMap Haiti. *Chiara Rossitto· Luigina Ciolfi*, 311.

31. White, J. I., Palen, L., & Anderson, K. (2014). Digital mobilization in disaster response: The work & self-organization of on-line pet advocates in response to Hurricane Sandy. In *Proceedings of CSCW*, 866-876.

32. World Humanitarian and Country Icons (2012, August 16.) ReliefWeb. Retrieved from http://reliefweb.int/report/world/world-humanitarian-and-country-icons-2012.