mSafety: An ABM of Community Information-Sharing to Improve Public Safety

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Abstract

Millions of people globally have been forcibly displaced from their homes due to reasons beyond their control such as conflict, political upheaval, and environmental catastrophes. In many cases, these forced migrants seek temporary refuge in camps managed by nongovernmental organizations (NGOs). Although responsibility for refugees' well-being within camps belongs mainly to the NGOs and host government, the density of the camp population and lack of resources of service providers leads to a high degree of insecurity. Building off successful models of mHealth, or utilizing mobile technologies to address healthcare needs, this paper explores the possibility of using communication technologies to address personal security issues. Using agent based modeling techniques, this paper examines the ways in which information about incidents of violence are communicated through a closed population. In this way, the authors advocate for the use of mobile phones in an m*Security* context that empowers forced migrants to become active members in reducing incidents of violence within refugee and internally displaced persons camps.

Contextualizing the Model

As of the beginning of 2011, the United Nations High Commissioner for Refugees (UNHCR) manages the safety of approximately 33.9 million of the 43.7 million people globally who have been forcibly uprooted due to political, economic, or environmental events (UNHCR: The UN Refugee Agency 2011). Fleeing insecurity, refugees and internally displaced persons (IDPs) often seek safety within camps established by nongovernmental organizations (NGOs) or other spontaneous settlements. In 2010, in the North Kivu region of the Democratic Republic of Congo (DRC) alone, the UNHCR assisted an estimated 100,000 IDPs in twenty four "spontaneous" settlements (UNHCR: The Refugee Agency 2011).

The arduous journey to reach a safer living space is often accompanied by severed familial and community-based social network ties, both from the disorientation of flight as well as the tragedy of conflict (Martin 2004, 134-141, Segal and Mayadas 2005, 158). Whereas social networks may have provided some amount of security and accountability in previous living arrangements, these mechanisms are generally fractured at best upon arrival at a camp, creating a sense of insecurity among displaced persons (Martin 2004, 51). Furthermore, combatant forces often move and intermingle with forcibly displaced populations, using them as conduits for resources such as food, human capital to fill militia ranks, relief supplies, and forced labor (Opaye 2005, Jacobsen 1999, Tanner and Stedman 2003). Although aid workers are encouraged to screen for combatants within the forced migrant population (Jacobsen 1999), discerning the exploiters and criminals from the actual vulnerable group in flows of thousands upon thousands of people can be insurmountably challenging. Additionally, since the majority of forced migrants live in developing countries, host governments may not have the resources to adequately staff security initiatives (Opaye 2005, Jacobsen 1999).

Development and Mobile Phones

mHealth, or mobile-based/mobile-enhanced health initiatives, has become increasingly popular in countries with limited healthcare infrastructure to deliver services to dispersed populations, particularly in rural areas (mHealth Alliance 2010, Dwivedi, et al. 2006, United Nations Foundation, Vodafone Foundation, and mHealth Alliance n.d.). mHealth works by allowing healthcare providers to distantly supply patients with education and medication reminders, among other services. Medical staff can also remotely monitor patients and collect biometric data through text messaging. Many countries have begun implementing mHealth initiatives to reach the United Nations
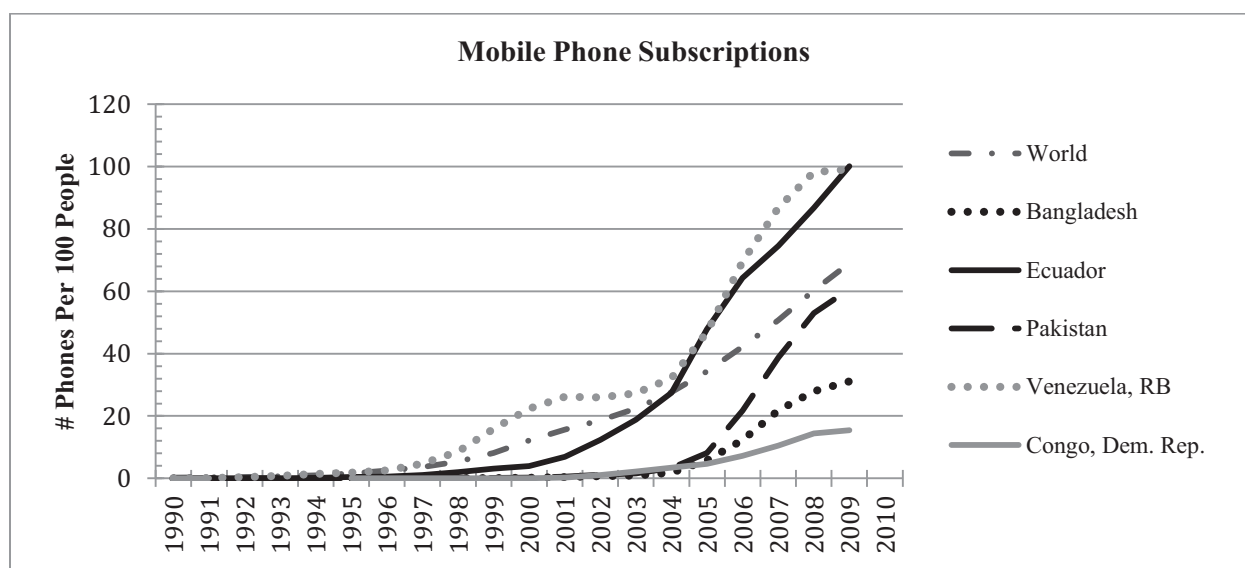
Mobile Phone Subscriptions

Figure 1: Mobile Phone Subscriptions in Top 5 Countries Hosting Refugees

Millennium Development goals, such as reducing maternal and infant mortality and providing wider access to healthcare (Rasmussen 2010).

Inspired by the success of mHealth technology and the increasing accessibility of mobile phones in developing countries, the authors of this paper questioned whether mobile phones could be utilized to increase security as well as health. During a visit to Kiziba refugee camp in the Lake Kivu region of Rwanda earlier this year, one of the authors noted the widespread use of pay-per-use mobile phones. Despite the lack of access to electricity within this camp, mobile phones could be recharged at small shops equipped with solar power.

Mobile phones in many developing countries, particularly in Africa, have become less of a luxury and more of a necessity. Bangladesh, Ecuador, Pakistan, and Venezuela together host 92% of the estimated 1.6 million people living in refugee-like situations (UNHCR: The UN Refugee Agency 2011). Figure 1 depicts mobile phone subscriptions in each of these countries and includes the DRC due to its relevancy in the current study (International Telecommunication Union, World Telecommunication/ICT Development Report and database, and World Bank estimates. 2009). Although Pakistan, Bangladesh, and the DRC lag behind average global levels of mobile phone access, number of subscribers in all cases has gone up precipitously since around 2005. This increase in mobile phone access, even in countries burdened by development issues, indicates the feasibility of utilizing this technology to reach certain development goals, such as providing security for displaced populations.

Practically speaking, mobile phone access within refugee and IDP camps may not always be an option, but if available, this technology may be capable of fostering, to some degree, networks to report acts of violence (Barrow 2006). The UNHCR and World Food Program have been utilizing text SMS messages through mobile phones to alert urban refugees to food distribution sites since 2007 (Pagonis 2007). Estimating that 78 percent of refugees and IDPs in East Africa have access to mobile technologies, a Denmark-based NGO began a collaborative campaign to help forced migrants in Uganda reconnect with lost family members through services available from their mobile phones (Refugees United 2011). Among other uses of technology to improve the lives of refugees, the UNHCR is experimenting with capabilities that would allow processing of forced migrants to be done via mobile phones. This data would be stored in a cloud, facilitating faster reunification of separated family members and centralized data storage for more efficient processing (Malik 2011).

Generally, information dissemination within camp situations occurs predominantly among a select group of refugees somehow determined to be leaders. Whether or not the information actually gets passed along is entirely dependent on the choices of these select few (UNHCR: The UN Refugee Agency 2006). Given the current trends in mobile phone use in the context of the developing world, it is reasonable then to suggest the use of mobile technologies to meet informational needs of a wider population of refugees. When physical security is under-sourced, communities may be able to increase their collective safety through the use of low-cost technologies like mobile phones by monitoring and sharing information about violent incidents. As mentioned above, many refugees al-

ready possess mobile phones and infrastructure is generally in place to make use of them even in the context of forced displacement. Implementing a plan to utilize this existing structure would be relatively low-cost for the camp funding organizations.

It is important to note here that the concept for this model is not based on the expectation that users report into some central database that will dispatch security as needed to certain areas, though if resources permit, that would also be helpful in improving security. The idea here is that, like with mHealth, mobile phones allow for individuals to take control and become part of the solution to the problem. Rather than sharing important first-hand knowledge about incidents of violence only with a close set of friends and family, mobile phones might provide a way for district-sized areas within a camp to monitor their own security threats. Through mobile phone technology, agents become active participants in naming and shaming criminals as well as developing a larger picture of where danger hotspots exist and how best to avoid them. This type of community-based approach to solving problems is in fact outlined in the UNHCR operational security handbook as essential to developing strategies that are effective and durable (UNHCR: The UN Refugee Agency 2006, 14, 17). As in the case of mHealth, service providers could also utilize this data to prioritize service to the portions of the population most in need of assistance. In the context of refugee camps, the successful implementation of an mSafety strategy would allow limited security staff to better position themselves to ensure high levels of safety among the refugees and IDPs.

Mugunga III

Though each forced migration situation is different, many camps share common themes. Among the many camps operating under the umbrella of UNHCR, Mugunga III serves as an illustration of the kinds of insecurity endured by refugees and IDPs.

Political and social unrest in the late 1990s led to the forced displacement of well over one million people in the Democratic Republic of Congo, among other countries in the Great Lakes Region of Africa (Central Intelligence Agency 2011). Despite a calming of the political climate in the DRC which has allowed many IDPs to leave settlements and return home, violence continues to plague certain areas (UNHCR: The Refugee Agency 2011).

Mugunga III (see Figure 2) is an IDP temporary settlement in the North Kivu region of the DRC that houses the most vulnerable of the populations remaining after the closure of camps Mugunga I and Mugunga II in 2008 (Redmond 2009, van Bruaene, Scheuermann and Lukmanji 2011, 30). Though it can accommodate up to 60,000 peo-

Figure 2: Map of DRC and Mugunga III
(UNHCR & UNOPS 2010)

ple, it is currently the home to approximately 4,625 individuals in 1,210 homes (UNHCR & UNOPS 2010).

Recent outbreaks of violence, in particular attacks on humanitarian aid workers in the DRC, have reduced many NGOs' capacity for providing safety and aid for vulnerable populations (Mubalama 2011). IDPs within the Mugunga III camp have become particularly vulnerable to these violent outbreaks as security measures fall short of effective. Women in Mugunga III, as with forcibly displaced women more generally, become vulnerable to attacks while fetching necessary resources such as firewood. Men often refuse to accompany women to retrieve resources because encounters with combatants mean certain death for them, whereas women often escape after being beaten and raped (Schmitt 2011).

Developing the Model

The focus in this study is individual behaviors operating heterogeneously and autonomously to produce macro-level effects. Due to the interest in individuals harnessing the power of mobile technologies to increase group security, agent based modeling techniques were appropriate for this particular research question. Agent-based models are a valuable method for investigating research questions characterized by: autonomous agents who interact repeatedly over time; nonlinear cause-effect relationships; a large number of variables that exhibit interaction complexity; difficulties with gathering empirical data; and a scarcity of events (Lustick, Miodownik and Eidelson 2004). Arguably, all five conditions characterize the study of using mobile phone-based, crowd-sourced information about incidents of violence to increase personal security within forcibly displaced populations.
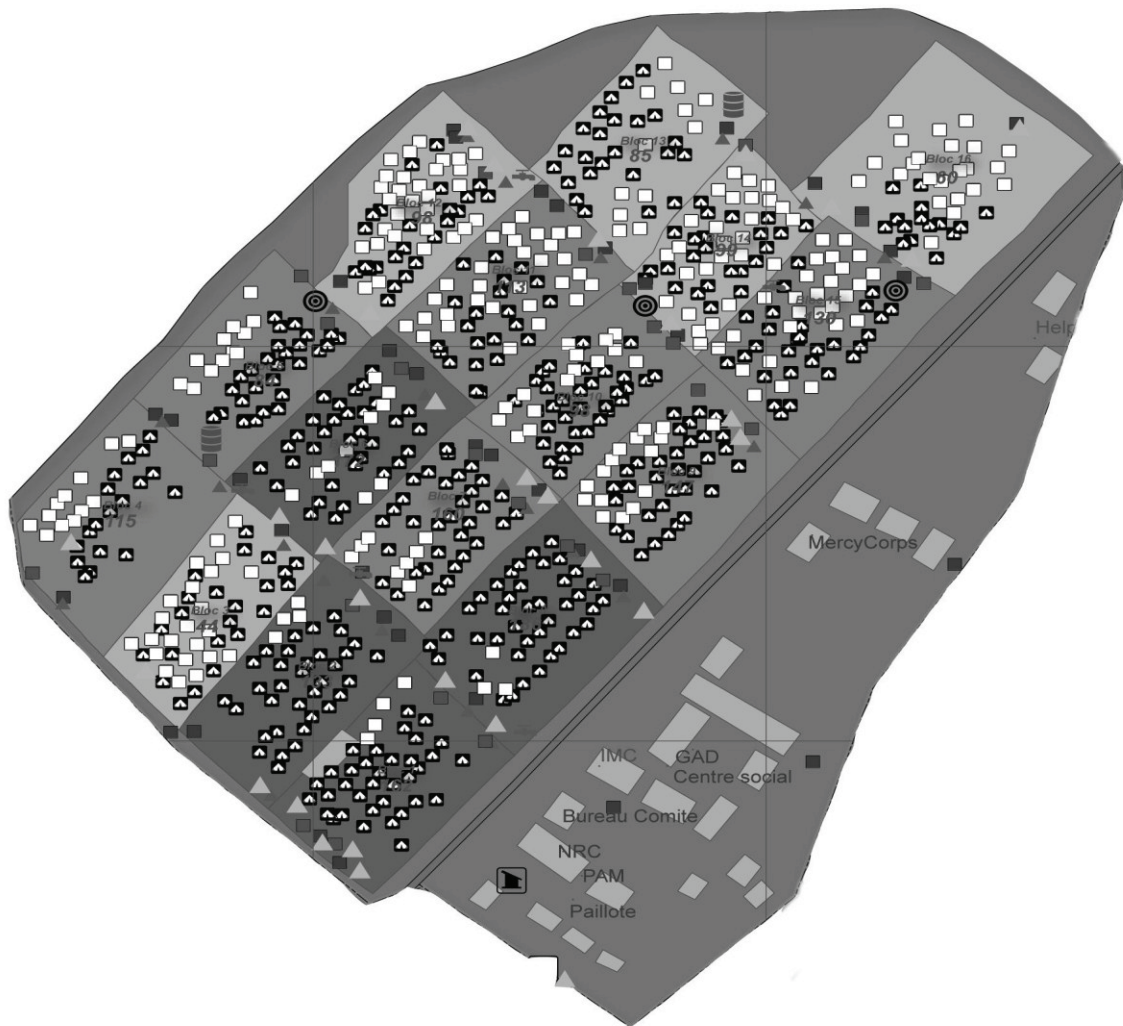
Figure 3: Map of Mugunga III used in the Model (UNHCR & UNOPS 2010)

Though there is great diversity of people within refugee camps, the model restricts the scenario to three types of agents: refugees, insurgents, and security forces. While this limits the presence of other types of individuals, aid and healthcare workers for instance, it sufficiently covers all necessary actors to address security concerns. Since aid workers have been the target of attacks as well, for simplicity, it can be assumed that their participation in security is included within the set refugee agents. Like refugees, they might travel around the camp between resource distribution sites. Just as refugees might communicate safety issues to one another within the camp, it can be assumed that aid workers would also benefit and participate in that type of information exchange.

Simulated Camp World

To help contextualize the situation of security in refugee camps, a map of Mugunga III IDP camp was utilized for

the model (see Figure 3). Agents navigate pathways that reflect actual main walkways in this particular camp. Locations of facilities, such as latrines, housing structures, and water sources were imported based on the actual layout of Mugunga III. These are depicted visually in the model as small squares colored to reflect their respective resource type (see Figure 3 and Figure 4). This particular camp is just one example of a possible settlement configuration. As is expected from settlements that often spontaneously grow during moments of mass migration, it is impossible to create a camp that models a predominant layout. Mugunga III was chosen based on the availability of detailed UNHCR maps and its documented accounts of non-refugees instigating violence.

Agent Intelligence

Each of the three types of agents manages different decision criteria in order to achieve its goals. Visually, refu-

gees are depicted in the model as blue people-shaped agents (see Figure 4). Refugees are given a randomized list of destinations that they must reach in order to collect resources and increase their well-being. The refugees navigate main pathways through the camp in order to get to their intended destination. If the destination is successfully reached, the refugee adds to his/her pool of resources. Agents only veer off main walkways if they are going to their house (generally in the spaces between the walkways) or the security stations located in the open space to the south of the camp.

Insurgents are allowed to roam off the walkway. This feature is meant to reflect that these agents are not necessarily operating freely within the camp, but rather trying to keep from being noticed by security forces. Rather than approach a distribution site to collect a resource, they lurk outside and wait for refugees to come. By "lurking," we mean here that an insurgent will hover around a resource distribution site waiting for other refugees to come regardless of whether he has already stolen from someone. After a certain period of time, the insurgent will move on to lurk at a new resource site.

If a refugee approaches and there are no security forces around, the insurgent may take resources in two cases. First, if there are more insurgents at the site than refugees, the refugees are overpowered and become targets of violence. Second, if the refugees at the distribution site are all female and the ratio of refugees to insurgents is no more than 3:1, the refugees become targets of violence. This last scenario represents acts of gender based violence to which even small groups of women in camp situations can become victims. Although refugees can only gather one additional resource at a distribution site, if he or she is a victim of violence at that site, then two units of resource will be lost. This is meant to reflect the emotional and/or phys-

Figure 4: Agent Perspective in NetLogo (Wilensky 1999)

ical tolls as well as the loss of a resource that might be incurred if one is the victim of a violent act. If a refugee has lost all of her resources, she then dies.

Security forces, the final agent type, are represented visually in the model as flags. The presence of the forces at distribution sites deters insurgents from stealing from refugees. Unfortunately, as mentioned above, security is often under-resourced and is spread very thin over a vast, densely populated area. Though they are depicted by a single agent in the model, these agents are interpreted to be travelling in groups large enough to deter minor security threats. For simplicity, in this model security forces wander the main section of the camp attempting only to deter crime.

Agent Communication

In the model, an on/off switch controls whether agents have access to communication technology analogous to mobile phones. When there is no technological solution for conveying sites and acts of violence, agents talk to those with whom they come into close contact. After either being the victim of or witness to an act of violence at a resource site as described above, refugees will tell others who come within a very close distance, meant to represent a conversational exchange about where the event occurred. Eventually, emotions of the event fade and the refugee "forgets" to tell others about the incident. The memory of violence for refugees in this model is limited to only five incidents, so he or she may continue to avoid a site of violence until it is forgotten and replaced by more recent information.

If the agents are able to use communication technology, they are initialized to be part of a random sized network. This is intended to reflect the fact that some refugees will have a wider influence than others. If a refugee becomes the victim of or witness to an act of violence, the site is recorded in the agent's memory and he instantly tells all of the members of his network. These refugees also record the site in their respective memories and will continue to avoid it until it is later forgotten. As before, agents will continue to spread knowledge of a site of violence by word of mouth. This act of sharing with a network of agents simulates information-sharing among community members through text messaging. Once a refugee has heard from another agent that a certain resource site is dangerous, that agent will adjust its destination agenda accordingly until that incident is no longer in her memory.

This type of text-based information-sharing is easily conceived when considering what happens when, upon reaching a traffic jam, one might text friends or family who also travel that route so they can adjust their usual course. In a similar way, refugees utilize a messaging system within the model to warn others of dangerous spots in order to adjust their intended course.

Learning and Adaptation

As described in the section above, agents learn through word-of-mouth or communication technology about which dangerous areas to avoid. When refugees run out of resources and are removed from the model, new agents take their place. Agents in the model remember their intended destination list as well as the five most recent incidents of violence they have heard about or witnessed. When certain agents leave the model, they are replaced either with agents that replicate the best performers or randomly generated new agents. Here, best performance is gauged by the amount of resources the refugee has collected. The best-performer replacement mechanism allows for conservation within the model of top performing strategies. Introducing, with a smaller percentage, randomly generated new agents into the model allows for variation in strategies that might in turn lead to even better outcomes. Through these mechanisms, the system begins to move toward one of community-wide surveillance and intelligence sharing that uses "crowd-sourced" information to reduce the risks of personal violence.

Next Steps

The model described thus far has been developed as a prototype to explore and demonstrate the feasibility of implementing an agent based model of information sharing in displaced populations to increase collective security. Though tailored to the Mugunga III IDP camp, this model could easily be extended to reflect other geographical layouts. Likewise, an extension that models other types of violence that occur within refugee populations, such as ethnic conflict, could be implemented. Due to the wide variety of displacement camp situations in the world, the development of workable, emergency solutions to restore and maintain personal security of refugees must be dynamic with rapid turn-around. Agent-based modeling is well suited to this task as extensions to the model and slight changes in code allow the researchers to evaluate success of programs in a controlled experimental environment.

Initial tests on the model indicate that information sharing indeed affects the overall health (or resource wealth) of the non-insurgent population. Even with the prototype model, the low research costs of exploring mSafety as an option in refugee camps using agent based models as opposed to real-life trial and error initiatives is apparent. The next step in evaluating the effectiveness of mSafety in the model will be to implement a factorial design experiment in which the ability of mobile phone networks to reduce incidents of violence is systematically explored. The experiment will focus on the effectiveness of mSafety given varying refugee population size, numbers of insurgents in the model, and availability of security forces.

Conclusion

Increasing security is extremely difficult in situations where traditional social network structures have been fractured, populations are extremely dense, resources are scarce, and the ability of NGOs and host governments to provide additional security forces is limited. This paper does not intend to suggest that mobile technologies provide *the* solution to security problems in the context of forced migration. In reality, the security situations of refugee and IDP camps are varied and complex. This paper does, however, posit that mobile phones would provide a cost effective way to empower individuals to participate in raising their own personal security and in turn meet collective security needs.

Additional benefits to utilizing mobile phones as information-sharing mechanisms in forcibly displaced populations abound. Addressing challenges associated with information dissemination in refugee camps, the UN Operational Protection guide notes that women, children, elderly, and the disabled tend to be the most marginalized in access to information (UNHCR: The UN Refugee Agency 2006). Due to lack of access to important, official information, rumors often circulate out of control. Dissemination of pertinent information through mobile phone technologies would help prevent bottlenecks from forming at the privileged groups of leaders that emerge within camps. Additionally, through mobile phone technology, aid workers and NGOs could address the problem of information flowing in only one direction (UNHCR: The UN Refugee Agency 2006). This deficiency of bi-directional educational information exchange between refugees and aid workers might also be easily addressed through the use of mobile phones. Text messaging would allow for more regular feedback from the population about what issues should be prioritized, including security danger zones established through the mSecurity model proposed in this paper. A dual system of bi-directional text messaging and mSecurity networking would allow refugees to participate actively in increasing collective security through the identification of troubled areas within the camp and perhaps even the apprehension of perpetrators of violence.

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