American Red Cross

International Federation of Red Cross and Red Crescent Societies

A Vision for the Humanitarian Use of Emerging Technology for Emerging Needs

STRENGTHENING URBAN RESILIENCE

Contents

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Executive Summary

The Red Cross and Red Crescent and its coalition of partners strive to make 1 billion people safer by 2025.

In the next decade, we believe emerging technologies will play an important role in facilitating community-level knowledge and health, connection, organization, economic opportunities, access to infrastructure and services, and management of natural resources—that is, the characteristics that make a safe and resilient community. To move closer toward this ambitious goal and address the challenges that commonly delay or prevent people living in urban centers from making a full recovery following emergencies, the Red Cross and Red Crescent designed the Global Dialogue on Emerging Technology for Emerging Needs.

In the first 15 months of the dialogue, the Red Cross and Red Crescent conducted regional consultations in six technology hubs to explore barriers to resilience and to learn the underlying attitudes, beliefs, questions and concerns influencing each urban community's perceptions of emerging technology. We honed in on emerging technology solutions they believe will not only address their emergency needs but also enhance their daily lives, as they are introduced to consumers over the next five to 10 years.

Throughout the dialogue, community members and experts shared their advice and priorities with the Red Cross and Red Crescent. Their sentiments serve as formal recommendations to assist technologists, business leaders, governments, researchers and nonprofits as they consider the design, use and cost of these innovations. The Red Cross and Red Crescent urges these actors to take note of the following five commonly shared requests from across the globe, ranging from the way technology solutions are introduced to the most desired humanitarian use cases.

1. Engage local community members in the design, manufacturing and introduction of new technology solutions.

2. Support consumer access, management and ownership of emerging technologies.

3. Research the impact of technology on community resilience.

4. Establish supportive policies, systems and guidance for the development and use of emerging technologies.

5. Invest first in four emerging technology use cases that address actual barriers to resilience:

   - Wearable devices for providing early warning, supporting search and rescue, and reconnecting families

   - Unmanned aerial vehicles for temporarily restoring communications networks and delivering critical relief items, such as medicines, post-disaster

   - Smart home sensor networks for sensing and reporting fires in informal settlements/slums

   - Biometric scanners in ATM-like kiosks for restoring lost documentation to prove identity, access assistance and reconnect families

To achieve these ambitious goals, the Red Cross and Red Crescent will need the support of a coalition composed of technologists, business leaders, government officials, researchers, policy experts, nonprofits and others. To advance these ideas and remove the barriers to community resilience, each sector will need to devote its specialized expertise as well as resources of time, funding, and unique products and services. And to meet the growing global demand for innovative tools and approaches, we also will need to coordinate our work, identify additional collaborators and leverage each other's strengths.

Introduction

Futurists and consumers agree that emerging tools like 3D printers, augmented reality software, biometric scanners, robots, smart cars, smart home sensor networks, unmanned aerial vehicles and wearable devices are sparking another technology revolution.

The Red Cross and Red Crescent also believes that these emerging technologies hold the transformative power to strengthen the resilience of urban communities. Even more, these tools will be uniquely prepared to respond to emerging political, societal and environmental realities, enable new consumer behaviors and accommodate the increased complexity, scale and resources of cities.

The risk of disasters is accumulating rapidly, with climate change increasing the intensity and frequency of extreme weather events and urbanization exposing greater numbers of people to their impacts. In the last 20 years alone, 4.4 billion people have been affected and 1.3 million killed by disasters, while economic losses have been estimated at $2–3 trillion USD, according to the United Nations.[1] On top of that, rapid, haphazard urban development is driving up risk in cities in seismic zones. For example, if an earthquake were to hit Kathmandu, Nepal, tomorrow, it is estimated that more than 100,000 people would be killed, 300,000 injured and 1.8 million displaced.[2]

Compounding these risks, the number of people forcibly displaced has increased to 51.2 million, many of these becoming vulnerable urban dwellers without access to employment or social protection.[3] In addition, urban violence has led to situations where deaths linked to drug supply and criminal and territorial gang activity are even higher than those in many armed conflicts. But it is not just the mega-disasters or international conflicts that are of concern, for many people "everyday risks"—such as not getting enough to eat, not being able to pay to go to the doctor, sewage flowing in the street or an uncontrolled fire ripping through slums—are far more acute and imminent than disasters.

In light of these immense needs and the imperative to reduce suffering, the Red Cross and Red Crescent designed the Global Dialogue on Emerging Technology for Emerging Needs. The dialogue is a multi-year initiative to inform the design, use and cost of innovative technology solutions and evaluate their impact on urban resilience in collaboration with other sectors.

As the Red Cross and Red Crescent and its coalition of partners strive to make 1 billion people safer by 2025, emerging technologies will play a particularly important role in amplifying efforts to facilitate community-level knowledge and health, connection, organization, economic opportunities, access to infrastructure and services, and management of natural resources.

Tomorrow's challenges, some of which are unimaginable today, will require new and improved solutions. We are moving deeper into the age of automation, and the next decade will transform how we communicate, learn, make money, address our health, move around, and access products and services. The global dialogue convened by the Red Cross and Red Crescent aims to influence novel tools, not yet scaled, to ensure they understand and support the way that people and disasters will behave in the future, as well as complement and improve upon traditional practices and low-tech approaches. This collaboration is imperative to ensuring these emerging technologies meet the needs of vulnerable populations, when they need them the most and at a price they can afford. Preparing for their arrival in the marketplace will help to mitigate potential disruption and increase acceptance and demand.

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[1] Effective law and regulation for disaster risk reduction: a multi-country report, United Nations Development Programme (June 17, 2014) – See more at: http://www.undp.org/content/undp/en/home/librarypage/crisis-prevention-and-recovery/effective-law---regulation-for-disaster-risk-reduction/

[2] Nepal: Preparing for an earthquake in the Kathmandu Valley, United Nations Office for the Coordination of Humanitarian Affairs (May 21, 2013) – See more at: http://www.unocha.org/top-stories/all-stories/nepal-preparing-earthquake-kathmandu-valley

[3] Global forced displacement tops 50 million for first time in post-World War II era, Office of the United Nations High Commissioner for Refugees (June 20, 2014) – See more at: http://www.unhcr.org/53a155bc6.html

Methodology

The Global Dialogue on Emerging Technology for Emerging Needs is a groundbreaking initiative designed to challenge the Red Cross and Red Crescent and its collaborators to think differently about the humanitarian applications of technology. For decades, we have focused on the tools humanitarians use, investing in infrastructure and business technologies to meet the operational needs of our institutions. The digital age, however, has turned the traditionally top-down model of humanitarian action on its head. The people on the receiving end of emergency aid, who until recently were far from where decisions are made, can now identify and voice their own needs directly. They can also improve their knowledge, design their own solutions and expand their coping strategies through technology by mobilizing local, national and sometimes global support. In this vein, the dialogue focuses on meeting the needs of communities through consumer technologies, including solutions that are (or will become) directly accessible to individuals and enhance their daily lives. We believe this community-centered approach will also support other humanitarian initiatives designed to close the digital divide and maximize today's technology solutions.

Dialogue Stakeholders

The dialogue is sponsored by the American Red Cross and the International Federation of Red Cross and Red Crescent Societies and is receiving material and financial support from the private sector, International Committee of the Red Cross, 10 additional national Red Cross and Red Crescent societies, and two global reference centers—the Red Cross and Red Crescent Global Disaster Preparedness Center and the Climate Centre.

The Red Cross and Red Crescent served as the convener, and the specific problem sets and solutions were sourced among at-risk community members, technologists, business leaders, government officials, academics, researchers, humanitarians, journalists and other stakeholders. It is important to the Red Cross and Red Crescent that the dialogue be open and inclusive of community members as well as institutions from multiple sectors throughout every stage, and to identify and take action collectively against our shared interests.

During the dialogue's first 15 months, the Red Cross and Red Crescent engaged more than 1,000 collaborators across six continents. The most active participants included:

- Disaster survivors
- Emergency managers and first responders
- City planners
- Technologists
- Business leaders
- Policy analysts
- Journalists

- Foundations
- Government officials
- Academics
- Researchers
- Humanitarian organizations
- Development institutions
- Health experts

Dialogue Locations

In 2013 and 2014, the Red Cross and Red Crescent hosted 12 convenings and participated in several others hosted by collaborators to advance the dialogue. The locations of the Red Cross and Red Crescent events were selected based on the size and complexity of the urban metropolis, their proximity to growing disaster-related needs, their reputation as innovation hubs, and the interest of co-convening partners. The events hosted by the Red Cross and Red Crescent include those in the following locations:

- Argentina (Buenos Aires and La Plata)
- Ireland (Cork and Dublin)
- Kenya (Nairobi)
- South Korea (Seoul)
- United Kingdom (London)
- United States (Palo Alto and San Francisco)

Initial Research and Emerging Technology

The Red Cross and Red Crescent has a proud history of technology use in disasters, dating back to the 1800s when telegraphs and telephones were considered cutting edge. Today, several ongoing initiatives—including those bringing connectivity and access to rural communities, providing early warning, administering cash grants, assessing risks and reconnecting separated families—have improved the speed, efficiency, reach, effectiveness, accountability, transparency, connection, knowledge and visibility of the humanitarian sector. The Global Dialogue on Emerging Technology for Emerging Needs leveraged these successes to explore an entirely new, yet complementary, set of opportunities—specifically, those expected to disrupt the status quo and transform society over the next decade.

In September 2013, the Red Cross and Red Crescent began researching emerging technologies in earnest. One month later, the Red Cross and Red Crescent published its standout report, *"World Disasters Report: Focus on Technology and the Future of Humanitarian Action"*, in collaboration with the Harvard Humanitarian Initiative. At the time, few organizations, outside of academia and government defense departments, were exploring how the next wave of technology advancement could assist humanitarian action. To better understand the emerging technology landscape, we consulted futurists, technologists, business leaders, donors, academics and multi-lateral organizations through focus groups, events and individual conversations. We consulted several organizations and coalitions tackling resilience-related issues, as well as those responsible for well-known technology initiatives tied to humanitarian and development interests. Together, we recognized numerous gaps for the Red Cross and Red Crescent to fill as well as ways to connect and coordinate new activities with ongoing initiatives. We looked at these opportunities through the lens of the seven Red Cross and Red Crescent Fundamental Principles, and considered those that would help address some of the world's greatest humanitarian challenges.[4]

Ultimately, we decided to focus the dialogue on eight specific emerging technologies and their capacity to strengthen urban resilience. Resilience serves as a unifying theme that connects the interests of several sectors and aligns with the strategic priorities of the Red Cross and Red Crescent. It is also an area that requires a diverse set of tools and approaches, and creates a meaningful opportunity to match emerging technology with emerging needs.

Among the dozens of technology solutions considered as potential aids, we selected these developing tools based on the following:

- Potential impact in at-risk, urban settings
- Ability to be accessed, managed and/or owned by individuals and communities in the next five to 10 years
- Technical and political readiness
- Shared value with partners
- Ability to scale

We also noted the importance of including different forms of technology beyond information and communications technology (ICT), such as robotics, manufacturing, medical and transport technologies. The emerging technologies of focus ultimately included 3D printers, augmented reality software, biometric scanners, robots, smart cars, smart home sensor networks, unmanned aerial vehicles and wearable devices as well as the increasingly diverse methods to power them and the applications tied to their effective use.

The Red Cross and Red Crescent ensured that the dialogue added the greatest value by devoting it to truly nascent solutions. This focus prevented the duplication of effort and allowed us to pursue incremental innovations to operational systems and already-scaled consumer technologies, such as mobile phones and their applications, through separate initiatives.

Framing Summit

In June 2014, the Red Cross and Red Crescent co-hosted with the Stanford Center for Philanthropy and Civil Society a one-day framing event in Palo Alto, Calif., entitled "Strengthening Urban Resilience with Technology Summit." Its purpose was to assemble 70 key stakeholders to establish a shared definition of resilience, anticipate future risks and vulnerabilities of urban communities around the world, practice human-centered design and launch a global initiative to match emerging needs with emerging technology solutions. In addition, it revealed the intersection of each participating organization's work in strengthening urban resilience and provided other natural avenues for ongoing collaboration.

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[4] Fundamental Principles of the Red Cross/Red Crescent: Humanity, Impartiality, Neutrality, Independence, Voluntary Service, Unity and Universality

Regional Consultations

Between June and December 2014, the Red Cross and Red Crescent conducted regional consultations, entitled "How Might Emerging Technology Strengthen Urban Resilience?" in six technology hubs to address the challenges that commonly delay or prevent individuals and communities from making a full recovery following emergencies. The regional consultations were envisioned as highly participatory, where the Red Cross and Red Crescent would act as convener and facilitator of the meeting, but the participants would drive the discussions, priorities and action items. Each regional consultation consisted of two separate events: a community town hall for residents of a disaster-affected, urban community followed by an expert workshop with international humanitarian organizations, national nonprofits, government officials, academics, social enterprises, technology developers, policy experts and other individuals from the private sector.[5] The format of the two events was adapted over the course of the dialogue to incorporate improvements in the process and to reflect local needs.

Chatham House Rule governed the dialogue and ensured participants could share openly without attribution; however, generalized summary reports for each convening are available at tech4resilience.blogspot.com.[6]

Community Town Halls

The Red Cross and Red Crescent conceived the community town hall events as a neutral and confidential space where community members and local organizations could voice their needs and challenges before, during and after emergencies. They could also describe their barriers to resilience, and share their attitudes and perceptions of emerging technologies that might strengthen their coping skills. Each town hall included a spectrum of community members, from ordinary people not involved with Red Cross and Red Crescent activities, to current volunteers and representatives of community groups familiar with the Red Cross and Red Crescent mission. The events hosted 15 to 40 participants and took place in community centers, schools and Red Cross venues over the course of three to four hours.

The participants were recruited by local Red Cross and Red Crescent teams through word of mouth, mass media and existing programs. Participants included caregivers, factory workers, guards, business owners, office workers, teachers, nurses, police offers, firefighters, scientists, students, journalists, and ethnic community liaisons, and they ranged in age, gender, income levels and physical abilities.

The town halls were professionally facilitated and structured by three main discussions: one on a recent disaster experience, one on the participants' main barriers to resilience, and one on their opinions, ideas and questions related to emerging technology. For the first discussion, the Red Cross and Red Crescent presented the greatest disaster risks in the local area and participants learned more about the role the organization plays in preparing for, responding to and recovering from shocks and stressors. These opening presentations followed a similar format in each location, and were localized to ensure relevance to the context.

Next, participants broke into small discussion groups to share their disaster-related needs and the specific challenges that delayed or prevented a full recovery in the past. Each group focused their conversation on a different area of concern, including communication, securing food/water/shelter, staying healthy, getting around, earning money and repairing/rebuilding.
The groups prioritized their top barriers and shared them with all participants before the dialogue transitioned toward solutions. These barriers stood as the primary problem sets to address through the dialogue.

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[5] The regional consultation in London, the first in the series and a pilot, only consisted of the expert workshop.

[6] When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed. – See more at: http://www.chathamhouse.org/about/chatham-house-rule#sthash.cbmm9k10.dpuf

The Red Cross and Red Crescent then shared basic information about eight emerging technology solutions, including their definitions, how they operate and practical examples to demonstrate their range and potential. Participants asked questions for clarity, and then the facilitators asked them to vote individually on which three technologies they felt most comfortable with and the three they felt least comfortable using.

Following their selections, participants reassembled in a full group to discuss the results. The Red Cross and Red Crescent sought to understand the underlying reasons for the voting pattern. The participants expressed their hopes and fears with each technology and shared ideas on how the technologies would or would not be useful in emergencies and in their daily lives. Of the three emerging technologies prioritized, participants then discussed which they believed would be the easiest and fastest for their friends, family and community to accept and adopt, and identified any perceived downsides to these technologies along with potential barriers that might prevent them from using the tools in the next disaster.

Finally, participants provided advice for disaster responders like the government, Red Cross and Red Crescent, faith-based organizations and hospitals. They honed in on ways these leaders could help facilitate consumer use of emerging technologies to strengthen their disaster resilience. At the conclusion of each town hall, the Red Cross and Red Crescent committed to a continuous and iterative process through which participants would help shape how emerging technology is used to meet emerging needs in their community.

Expert Workshops

Shortly after each community town hall event, the Red Cross and Red Crescent convened an expert workshop with 30 to 40 practitioners curated from various sectors (e.g., technology, business, government, humanitarian/development, philanthropy and academia). The workshops typically occurred at Red Cross venues or a collaborator's space over the course of five or six hours.

The facilitators led participants through a series of discussions to respond to the community's needs and challenges, add technical expertise to the dialogue, and develop rapid prototypes for emerging technology solutions. Primed with presentations about the local and global risks that urban communities face, the

participants shared their ideas about what makes a resilient community. After a detailed account from the community town hall, they also commented on the community's self-defined challenges, frustrations and unmet needs, including what surprised them about the information heard from the disaster survivors.

At this stage, the expert workshop participants were naturally eager to transition to a discussion about how to overcome these barriers and prepare for the future. The Red Cross and Red Crescent referenced the technology tools urban communities are currently using to cope with emergencies (e.g., social media, mobile phones, websites, mass media and handheld radios) and introduced the group to eight emerging technologies designed to respond to changes in consumer behavior and other societal shifts. This presentation was very similar to the one that the Red Cross and Red Crescent shared with community town hall participants, with the addition of two in-depth examples from lead discussants, sourced among the expert workshop participants. Participants also had the opportunity to share other emerging technologies that may have the potential to strengthen urban resilience.

Next, the facilitators led participants through an exercise to brainstorm specific use cases that could address the community's actual barriers to resilience. They wrote down their ideas independently using a basic formula
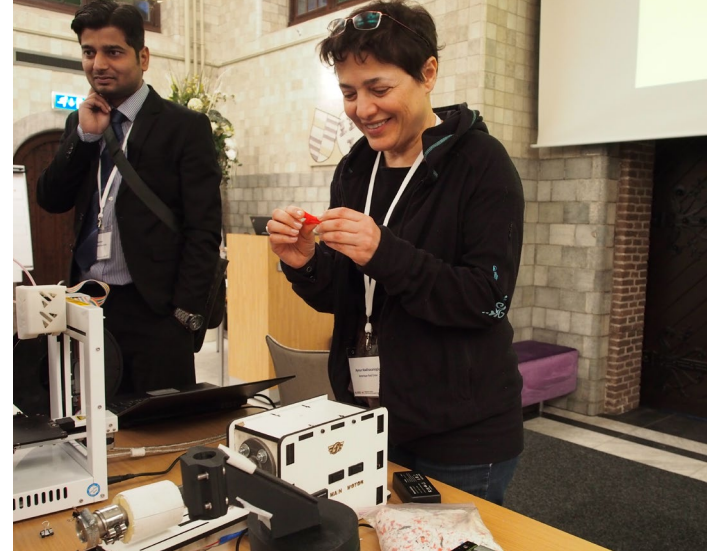
(i.e., community challenge/barrier + emerging technology + function + role before, during and after a disaster = use case). Participants were encouraged to focus on one or more of the primary emerging technology solutions for their use cases, but they were also able to incorporate other software and hardware tools as well as traditional, low-tech approaches. After sharing all the ideas with the full group, participants voted on the ideas they believed held the most promise in terms of strengthening urban resilience. The top six use cases were prioritized for further design based on the voting.

Before breaking into small groups to further develop these ideas, the Red Cross and Red Crescent told the participants the results of the community town hall vote and associated attitudes, beliefs, questions and concerns. This feedback was intended to reinforce the importance of human-centered design principles and impose reasonable design constraints. Groups formed to discuss each prioritized idea in more depth and develop rapid prototypes with drawings and diagrams to illustrate the concepts. Their discussions focused on the ideal users, the tools' range of features and benefits, the conditions that need to exist for the technologies to perform, stakeholders and potential barriers. Each small group briefly shared highlights from its conversation with the whole group, explaining how the technologies would be used/helpful in a disaster scenario in addition to everyday life. They also discussed the political/legal, social, security, ethical, environmental and financial conditions that would be needed for their recommendations.

Toward the end of the series, the agenda was modified to allow other participants to respond to the presentations as if they were investors, asking thought-provoking questions and voting again, choosing two out of the six ideas as the most viable. The full group concluded the workshop by discussing ways these ideas could be piloted and by brainstorming additional collaborators to assist in advancing the plans.

Before departing, the Red Cross and Red Crescent invited the expert workshop participants to join the community members to bring the most promising prototypes to life through an iterative process that begins with field-based experiments in 2015.

At the conclusion of the regional consultations, the Red Cross and Red Crescent identified eight use cases that the majority of community members, as well as experts involved in the dialogue, believed had the most value in daily life as well as before, during and after emergencies. It must be noted that their beliefs and priorities may not represent those of an entire community or country, but given the diverse range of participants, they represent an initial sampling and serve as good indicators of potential opportunities and barriers to be resolved through expanded assessments and field experimentation.

Prioritizing Summit

The Red Cross and Red Crescent organized a second summit in January 2015 at Nyenrode Business University outside Amsterdam, Netherlands. There, dialogue participants debated the most promising use cases from all six regional consultations and agreed upon four areas of initial focus, including:

- Wearable devices for providing early warning, supporting search and rescue, and reconnecting families
- Unmanned aerial vehicles for temporarily restoring communications networks and delivering critical relief items, such as medicines, post-disaster
- Smart home sensor networks for sensing and reporting fires in informal settlements/slums
- Biometric scanners in ATM-like kiosks for restoring lost documentation to prove identity, access assistance and reconnect families

Participants initiated planning for field experiments based on these use cases and helped identify the resources and additional partners needed to carry out the plans.

Field Demonstrations, Advanced Research and Advocacy

In early 2015, the Red Cross and Red Crescent began transitioning the exploration in emerging technology from dialogue to experiments. We are defining field experiment as "a short-term test to vet or prove an emerging technology use case before additional resources are allocated."

Together with our collaborators, we are reengaging urban communities to design and manage four short-term field demonstrations and pilot projects to prove the concepts prioritized through the dialogue. Innovation teams, composed of multi-sector volunteers, will establish the ideal technical specifications, make the necessary technological adaptations, develop applications to support the prioritized use cases and identify the most appropriate business models. They will then facilitate the tests for two to four months and document their insights to inform the design, use and cost of emerging technologies as well as expanded pilots, policy advocacy and future business development.

During this same period, the Red Cross and Red Crescent will also collect additional evidence to inform future investments and advocate for appropriate policies. Between 2015 and 2016, insights from the dialogue and experiments will be shared in national and global forums as well as at tech4resilience.blogspot.com.

Our Focus: Strengthening Urban Resilience

With this background in mind, it is clear the Red Cross and Red Crescent has an important role to play in influencing the tools that people use to anticipate, reduce the impact of, cope with, and recover from the effects of adversity. The global dialogue complements other urban resilience initiatives, including those organized by the United Nations, Rockefeller Foundation and the United States Agency for International Development, in that it places emphasis on the needs of individuals at the community level and their participation in the finding the best solutions. The Red Cross and Red Crescent believes strengthening community resilience will translate into stronger communities, and reduced vulnerability will be required to achieve the Sustainable Development Goals established by the United Nations.

Emerging Needs

Without immediate and appropriate action, a dangerous mix of population growth, unplanned urbanization and climate change will magnify disasters and health risks, and will have an exponential, catastrophic impact on people's lives around the world.

We are currently experiencing a widespread demographic shift as the global population urbanizes. Today, more than 50 percent of the global population lives in urban areas. By 2050, the United Nations expects that number to increase to 70 percent.[8] Many residents of these growing cities inhabit rapidly developed, unplanned and unregulated areas, such as "slums" that already host 1.5 billion people worldwide.[9] Poor construction and urban planning, the spread of infectious diseases, poverty, and crime and violence pose significant risks to residents living in these urban areas.

"Since its creation, the Red Cross and Red Crescent has been guided by a clear set of humanitarian principles and values that aims, in one way or another, to effectively contribute to building resilience," said Matthias Schmale, Undersecretary General of the International Federation of Red Cross and Red Crescent Societies.[7] Our long-term, ongoing commitment to strengthening global community resilience drives all of our priorities, program approaches and partnerships. As the world's leading humanitarian actor, we not only respond to natural disasters and armed conflicts, but we also support individuals and communities who experience repeated shocks in the form of economic and health crises. We strive to address the underlying vulnerabilities and build capacities to better cope with future shocks and stressors.

Throughout our collective 150-year history, the Red Cross and Red Crescent has developed specialized expertise and achieved significant impact in reducing community vulnerability. And in the face of future climate changes, urbanization and political unrest, our mission will remain critical to community development.

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[7] The road to resilience: Bridging relief and development for a more sustainable future, International Federation of Red Cross and Red Crescent Societies (June 2012) – See more at: http://www.ifrc.org/PageFiles/96178/1224500-Road%20to%20resilience-EN-LowRes%20(2).pdf

[8] World's population increasingly urban with more than half living in urban areas, United Nations (July 10, 2014) – See more at: http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html

[9] Need to Improve the Lives of Slum Dwellers, as Developing World Faces Dramatic Population Surge in Urban Centres, United Nations Millennium Project (January 17, 2005) – See more at: http://www.unmillenniumproject.org/reports/tf8_e.htm

Disasters are also increasing in frequency, severity, unpredictability and economic cost. In 2013, the strongest storm on record made landfall across several cities in the Philippines, damaging 1 million homes with high winds and strong waves.[10] The 2010 earthquake in Haiti was also one of the most devastating urban disasters, killing more than 222,500 people, mostly in and around its capital Port-au-Prince.[11] And developed countries are not immune to urban disaster risks. Some of most destructive urban disasters also recently occurred in highly developed countries, including the 2011 earthquake and tsunami in Japan and Superstorm Sandy, which hit the densely populated northeast coast of the United States in 2012.

But these trends, however intimidating, are not inevitable. Multi-sector collaborations are helping communities find their own solutions, assert their rights and play a full role in the disaster cycle, all of which helps reduce vulnerability and risk. Importantly, the discourse of resilience has put the focus on at-risk and affected communities themselves, increasingly moving attention from the supply to the demand side.

Put simply, resilience is about people's capacity to anticipate, prepare for, withstand and recover from a range of shocks and stresses, without compromising their long-term prospects. Strengthening community resilience to these challenges is the responsibility of all governments, an essential bridge between humanitarian and development organizations, and an increasing imperative for businesses. Communities and households with access to accurate and timely information, good levels of health care, social support networks and economic opportunities are less susceptible to hazards and faster to recover from shocks and stressors.

In 2011, the International Federation of Red Cross and Red Crescent Societies commissioned a study from ARUP International Development that identified six characteristics that define a safe and resilient community, as detailed in the following box.[12]

A safe and resilient community...

1. **...is knowledgeable and healthy.** It has the ability to assess, manage and monitor its risks. It can learn new skills and build on past experiences.
2. **...is organized.** It has the capacity to identify problems, establish priorities and act.
3. **...is connected.** It has relationships with external actors (family friends, faith groups, government) who provide a wider supportive environment, and supply goods and services when needed.
4. **...has infrastructure and services.** It has strong housing, transport, power, water and sanitation systems. It has the ability to maintain, repair and renovate them.
5. **...has economic opportunities.** It has a diverse range of employment opportunities, income and financial services. It is flexible, resourceful and has the capacity to accept uncertainty and respond (proactively) to change.
6. **...can manage its natural assets.** It recognizes their value and has the ability to protect, enhance and maintain them.

The dialogue also showed that while it is not an official characteristic of a safe and resilient community, optimism was another major driver among community town hall participants. As New York Times columnist David Brooks has said, "Most successful people begin with two beliefs: the future can be better than the present, and I have the power to make it so."[13]

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[10] Haiyan (Northwestern Pacific Ocean), NASA (November 20, 2013) – See more at: http://www.nasa.gov/content/goddard/haiyan-northwestern-pacific-ocean/#.VLZmPdJdUeo

[11] 2010 among deadliest years for disasters, urges better preparedness, United Nations (January 24, 2011) – See more at: http://www.un.org/apps/news/story.asp?NewsID=37357#.VLZmotJdUeo

[12] Characteristics of a Safe and Resilient Community: Community Based Disaster Risk Reduction Study, International Federation of Red Cross and Red Crescent Societies and ARUP International Development (September 2011) – See more: http://www.ifrc.org/PageFiles/96986/Final_Characteristics_Report.pdf

[13] Lost in the Crowd, David Brooks, The New York Times (December 15, 2008) – See more at: http://www.nytimes.com/2008/12/16/opinion/16brooks.html?_r=0

Community Barriers to Resilience

During the dialogue, community members voiced their disaster-related needs and the specific challenges that delayed or prevented a full recovery in the past. The following are areas that need strengthening to effectively cope with crises, according to each community town hall.

Seoul, South Korea

The first town hall, hosted by the Korean Red Cross in August 2014, focused on two recent and recurrent disaster experiences: natural landslides and human-caused, transportation incidents. Participants specifically recalled several fires in the subway system as well as the Sewol ferry sinking in April 2014. Participants noted that while tragic in nature, these disasters motivated the country to invest more in preparing for future calamities. Citizens have become increasingly aware of the risks and have altered their behavior to reduce their vulnerabilities and learn response protocols, shared the town hall participants. Today, most households, hotels, businesses and even public spaces, like the subway station, are equipped with best-in-class supplies and safety measures.

Through small-group discussions, however, community members conveyed they still struggle to effectively cope with these emergencies and their greatest barrier was emotional trauma, induced by the loss of life and injuries as well as feelings of vulnerability and guilt. They also noted that the loss of electricity and communications networks isolated people from sources of information and other community and family members. Additionally, the country lacks a widespread private insurance system—citizens expect the government will protect against damage or property loss, which leaves businesses and homeowners particularly vulnerable. The community members also noted the absence of a formal network to support collaboration between private institutions and the government in preparing for or responding to disasters. Finally, the town hall revealed facilities designated as shelters and evacuation centers, such as schools, are not always available post-disaster, especially when not all parts of society are affected and the venues are still needed for their primary function.

La Plata, Argentina

In La Plata, the community town hall, hosted by the Argentine Red Cross in September 2014, examined the record-breaking flash floods that occurred in April 2013. Participants noted their greatest barriers to resilience and areas that need strengthening before the next disaster. Transportation was a significant issue, and the floodwaters challenged people's ability to report to work and disrupted the local economy. Participants also agreed that being cut off from services, losing pets, pervasive and unrelenting mold issues, contaminated water, lack of access to affordable building materials, and high-interest loans challenged their recovery. Like the participants in Seoul, South Korea, many people in the community are still dealing with emotional trauma more than a year later. Grief over material losses and, in some cases, having lost neighbors and animals to the floods remains palpable.

Nairobi, Kenya

In October 2014, community members from Nairobi gathered at a community center in Mukuru Kayaba with the Kenyan Red Cross to share their experiences with recurrent house fires in their informal settlements. They described the challenges they face in preparing for, responding to and recovering from these deadly and destructive disasters, and the discussions revealed three key barriers. Their utmost concern was inadequate response coordination, from not knowing the phone number for emergency responders, to a lack of knowledge, equipment, resources, and even water for fighting fires themselves.

The layout of the settlements was also identified as an inherent hazard. With buildings and homes crowded together, roads are often inaccessible to emergency vehicles, allowing fires to spread rapidly. The labyrinth of narrow pathways between homes also caused chaos during an evacuation. The loss of possessions, medicines, money and livelihood tools from the fire itself, as well as looting and theft afterward, was also a major barrier to recovery. Most lacked fire insurance, hindering their ability to repair and rebuild. Some shared experiences with rent increases or forced eviction after a fire, too.

Finally, given the transient nature of the settlements, participants pointed out that there is a lack of cohesion and community structures to prevent fires, respond to them when they occur, and quickly recover afterward. This is compounded by the perception that cartels were running the settlements and people were using arson as a reason to escape debt and other obligations.

Cork, Ireland

The fourth town hall, hosted by the Irish Red Cross in November 2014, focused on Cork and surrounding areas that had been affected by severe flooding in 2009 and repeatedly since then. As with the other sessions, participants divided into groups to discuss the barriers that slowed or delayed their recovery. In Cork, community members prioritized their top challenges in the areas of repairing/rebuilding, staying healthy, communication and getting around.

When it came to repairing and rebuilding their damaged businesses and homes, lack of insurance was their ultimate challenge. Some people did not have flood insurance before, and as a result of the 2009 flooding, many others can no longer obtain coverage. Following the floods, electricians, plumbers and repairmen also increased their prices because of high demand. People needed a neutral and trustworthy source of advice. Lastly, after losing personal records

and proof of identity, community members experienced extreme difficulties in finding assistance post disaster.

In terms of staying healthy, Cork residents spoke of high levels of stress. Sudden evacuations were jarring, and forced relocations and government-imposed timelines for cleanup compounded the suffering. Additionally, several homeowners, who know that they can never sell their homes because they are uninsurable, conveyed feelings of hopelessness and despair. The floods also contributed to a loss of independence for some seniors as it became too difficult for many to move back home, even after the flooding.

With regard to communication, the flooding showed that the early warning systems were not adequate; alerts did not reach citizens in time and the rising waters caught the community off guard. Telephone and radio communications, as well as electricity, were also interrupted for an extended period of time, contributing to a disorganized and uncoordinated community response. In general, the community perception is that there is no effort by government to incorporate local knowledge into disaster plans.

The town hall participants also noted issues with getting around post disaster, complaining people did not know which roads were flooded and how best to navigate the affected area. This impacted their ability to report to work and earn money—desperately needed to recover and restart the local economy. The flooding also revealed a lack of plans to transport first responders and maintain critical emergency response networks, including ambulances.

San Francisco, United States

In December 2014, community members from San Francisco and surrounding cities gathered with the American Red Cross to share their experiences with major earthquakes that occurred over the past 25 years.

The barriers to resilience in this urban community ranged from maintaining food safety, managing waste and hygiene (especially since sewage pipes often run alongside drinking water pipes) and uncertainty about contamination of drinking water to keeping hospitals open and functioning, stocking pharmacies with essential medicines, maintaining first aid skills, and managing stress and anxiety.

Additionally, the participants expressed that many agencies are slow to respond to the economic needs of people impacted by disaster. Post-shock, it can be very difficult and time consuming to get loans and insurance payments. Many residents lack earthquake insurance, and when homes are designated as non-livable, people can become dependent on aid. Banks can be closed and

cash machines and credit cards may not work, leaving people with no way to access their savings to purchase critical supplies or jumpstart their recovery. In this scenario, the segment of the population that normally manages in cash might actually be more resilient. Another issue presents when products, such as food, are imported into a disaster zone without regard to how this surplus depresses the local (agricultural) economy.

On getting around, the group noted that it is difficult for people to return home following a disaster and for family members to find one another. In addition, getting supplies to businesses is difficult if roads are blocked or bridges closed. Obtaining fuel for cars is a challenge immediately after a disaster (especially with increasingly fewer gas stations in urban centers), and this perceived scarcity may expand to electricity in regions where the number of electric cars is growing. When elevators become inoperable after power outages, those living in high rises and those with limited mobility, including people with disabilities or the elderly, are particularly challenged. Additionally, many public safety employees do not live in the same cities where they work, and it is difficult for them to get in and out of the city to help after a disaster.

Next, town hall participants noted that they struggled to find shelters accommodating of their pets, disability, culture and diet. They also lack the knowledge and skills on how to turn their utilities on and off, clear debris, and upgrade and/or retrofit their homes to make them safer. In an earthquake situation, it can be particularly difficult to evaluate and repair homes due to ongoing aftershocks. Residents said engineers are expensive and unaffordable for most people. And following a disaster, it is common for unscrupulous contractors to take advantage of survivors, especially seniors.

Lastly, participants noted specific barriers faced by undocumented immigrants, who may be hesitant to seek assistance for fear of retribution and thus suffer needlessly.
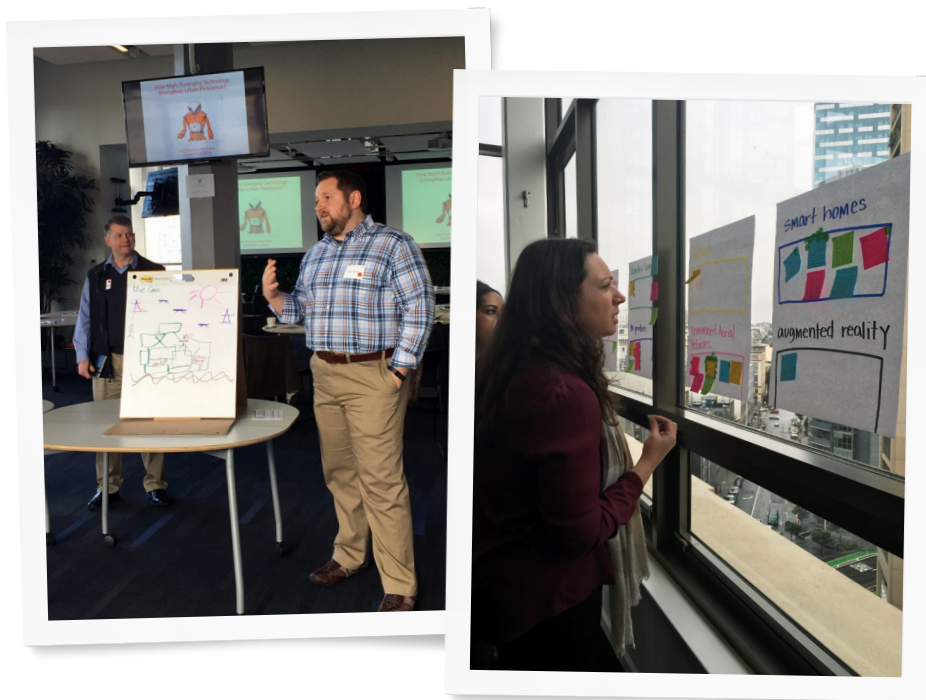
Emerging Technologies

While technology cannot address all barriers to resilience, it is a powerful enabler in strengthening resilience characteristics and empowering communities. Smart phones, social media, sharing economies and other tools are already helping to redesign emergency preparedness and response operations by:

- Facilitating community participation.
- Spreading lifesaving messages.
- Expediting service delivery even where power, connectivity, infrastructure and local training are lacking or limited.

As we enter the next generation of technology solutions, we also have the opportunity and responsibility to harness emerging tools that people can use and adapt to strengthen their own resilience to crisis shocks. The dialogue revealed that emerging technology solutions must possess eight of its own criteria to effectively improve and expand a community's ability to prepare for emergencies, help people respond to increasing risks, and assist their recovery.
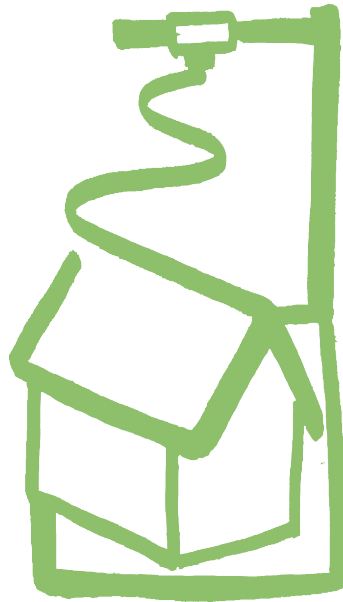

A Resilience-Strengthening Technology Solution…

1. **…is multi-purpose.** It is relevant and useful before, during and after emergencies as well as in daily life.
2. **…is human-centered.** It is developed in consultation with users and designed to address their wants and needs. It is therefore, by default, appropriate for the culture and lifestyle of its users and stakeholders. It is also supported by robust community outreach and education, and it is easy to learn and use.
3. **…is accessible.** It is open, inclusive and increasingly affordable for consumers.
4. **…is governed by trustworthy leaders, systems and policies.** It has access to relevant data and responsibly manages the data it generates.
5. **…is scalable or replicable.** It grows to accommodate demand.
6. **…is sustainable.** It is reliable and permanent. It has the required financial resources to support its current use and growth, but does not compromise natural resources or the interests of future generations.
7. **…is resilient itself.** It is rugged and able to withstand weather, wear, pressure and damage. It is power-efficient and increasingly leverages innovative sources of energy. It is supported by a network of redundant products and services, with which it is interoperable. It leverages the Internet when available but does not rely on it.
8. …enhances community-level **knowledge and health, connection, organization, economic opportunities, access to infrastructure and services,** and/or **management of natural resources**.

Among the many novel technologies under development, the Red Cross and Red Crescent believes that the following eight technologies are the most likely to meet these criteria in the next five to 10 years. Though they all currently have limitations and disadvantages, the insights in this section and the subsequent recommendations section can help break through these challenges and exponentially boost people's coping skills.

3D Printers

3D printing, or additive manufacturing, is the process of using a computer-controlled machine to add successive layers of material to create a three-dimensional object. In recent years, 3D printers have been experimentally used to produce the following:

- Molds and models
- Jewelry and fashion
- Ordinary household items
- Furniture and appliances
- Machines, tools and parts
- Vehicles, prosthetics and medical devices
- Human organs and tissues
- Food
- Houses and buildings
- Artificial plants and reefs
- Weapons
- Bridges and ramps

Price has become one of the leading factors in their growing popularity. Since 2010, the cost of 3D printers has decreased dramatically, driven by academic, hacker and do-it-yourself enthusiasts, with machines that used to cost $20,000 USD now available for less than $1,000 USD.[14] Many of the 3D printing designs are also open source, which has created a vibrant ecosystem of related or derivative 3D printers, designs and supporting technologies. These relatively sophisticated tools are being hacked, redesigned using e-waste and developed at more affordable price points by West African entrepreneurs, for example.[15]

While the cost of 3D printers is dropping quickly, and successive 3D printer designs are lowering the skills needed, today, they still require advanced technology skills to operate correctly. The potential component to be printed must first be designed using a computer-aided manufacturing process, the printer must be programmed to follow this design, and the correct raw material must be purchased and fed into the printer. Today's commercial 3D printers are also rather inefficient for high-volume manufacturing and better suited for rapid prototyping of items that are highly customized, such as prosthetic limbs or test units of products that then can be mass-produced using traditional manufacturing processes. In the near future, however, 3D printers are predicted to become faster and more efficient, challenge the traditional supply chains, and put the designing and manufacturing power into the hands of the consumer.

3D printing has the potential to disrupt traditional manufacturing processes by allowing ordinary people to produce or customize physical objects. The disruption potential is analogous to the way digital audio files have disrupted the traditional music business, however, without many of the intellectual property or copyright issues as the legal framework for making copies of physical items is less regulated than that of music. Like the early days of the music industry disruption, there is already a healthy ecosystem of hobbyists at the community level that are innovating new 3D printing uses. Often congregating in community places called maker spaces, they are evangelizing the use of 3D printing in education and community development. They are also becoming income-generating assets for entrepreneurs, and communities are sharing the devices like others might share cars.

3D printers were only moderately attractive as resilience-strengthening solutions to community members and experts engaged in the dialogue. The most interesting use cases for 3D printers, according to dialogue participants, included the production of medical supplies, disaster-resistant structures and building materials; replacement of important items such as heirlooms, cosmetic and functional modifications to their homes; and making spare parts to maintain the other emerging technologies. Across the globe, there was great interest in adding a collection of humanitarian relief items to the digital library of open source designs for 3D printers as well.

[14] 10 3D Printers for Under $1000 That Anyone Can Use At Home Today, Gadget Review (November 7, 2013) – See more at: http://www.gadgetreview.com/2013/11/10-3d-printers-for-under-1000-that-anyone-can-use-at-home-today

[15] A 3-D Printer Made from E-Waste; Popular Science (October 10, 2013) – See more at: http://www.popsci.com/article/diy/check-out-3-d-printer-made-e-waste

Communities also acknowledged the potential of 3D printing to generate income for the users, which lowers the threshold for individual access. However, they also had concerns 3D printers may disrupt the existing local manufacturing economy, potentially resulting in job losses for community members.[16]

In addition to speed and economic impacts, participants noted several other issues that may prevent 3D printer adoption unless resolved in the next generation of products. Today's machines are difficult to operate outdoors, especially when exposed to water, dust and winds, and they require regular maintenance and significant power. Participants also questioned the waste generated by the printers as well as their potential toxicity. These barriers must be resolved before their benefits can be fully realized by communities in disaster-prone, urban settings.

Augmented Reality Software
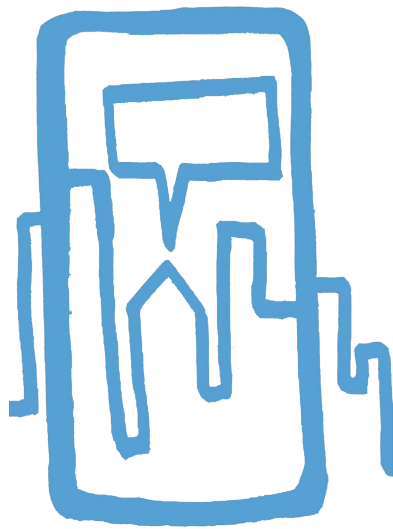
Augmented reality software adds a layer of computer-generated data, which cannot be seen or heard with human senses, into reality through smart glasses and other Internet-connected devices. One example of augmented reality is a smartphone application that adds contextual information like street names, historical events, restaurant menus or store hours, to the camera application in the form of labels or boxes as the user scans their surroundings. Museum headsets that play recorded information about art when the user is in close proximity to the exhibits and Google Glass, which combines both visual and auditory augmentation, are other examples of augmented reality software. A final example is seen when watching a sporting event on television; players cannot see the graphic enhancements, such as statistics and lines, which appear on the screen. It is important to note that augmented reality differs from virtual reality (e.g., video games), in that rather than adding to the existing world, the latter replaces the real world with a simulated one.

Surgeons, scientists, retail outlets and entertainers have led experimentation with augmented reality software. It is currently used to make informed decisions about archeology, shopping, interior design, surgeries and travel. Entrepreneurs have also developed several interesting applications to visualize climate changes, real-time translation and step-by-step instructions.

Participants in the Seoul, South Korea, workshop valued augmented reality software for crowdsourcing and visualizing community resources. The experts noted how mobile devices equipped with augmented reality software could be held in the user's line of sight (similar to taking a picture) and display computer-generated billboards and bubbles on the screen that correspond with people's homes and businesses, indicating those who are offering food, water, first aid and other services. This, they said, can be particularly helpful if the user is unfamiliar with the area, cannot see around the corner or is surrounded by high-rise buildings. The software would need to be updated regularly and provide near real-time information (generated by users) about fixed and mobile services as they become available and expire.

During the dialogue, participants also envisioned augmented reality software as a helpful way to "see" where potential disasters could occur based on past events and current modeling, such as visualizing potential flood damage at specific water levels. This emerging technology could also help community members locate available resources post disaster and pinpoint people buried by a landslide or earthquake, saving lives and increasing the speed of recovery. Community members and experts were equally interested in augmented reality-based disaster simulation to aid their preparedness education.

The primary barrier to accepting augmented reality software during the dialogue discussions, however, was simply unfamiliarity. Most participants had not seen augmented reality software in use and struggled to find the added value to distinguish it from accessing information from today's Internet browsers and applications. As consumers continue to move toward a hands-free lifestyle and as more data becomes publically available, experts anticipate augmented reality software and the visualization of information will become

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[16] To maintain their relevance and market share, many businesses are beginning to adapt and incorporate 3D printers into their products and services as well as their own manufacturing processes.

increasingly relevant. Cost was not a significant concern of the dialogue participants given that any consumer expense would be limited to the purchase of a nominally-priced application.[17]

Augmented reality software was perceived by some dialogue participants as a potential invasion of privacy, although others noted that the data used would be limited to what was publicly available. Participants wondered if they would have to disclose information they collected using augmented reality software to their insurance companies or the government, especially if they identified vulnerabilities in their homes.

The key to increasing interest in augmented reality software, according to the dialogue, is to simply make more applications that people can experiment with in their daily lives. This would make them more comfortable with the interface and more likely to consider a dual use in emergencies. Participants also requested that the information be available without Internet access.

Biometric Scanners

Biometric scanners are authentication devices using distinctive, measurable human characteristics and traits such as fingerprints, facial contours, DNA, palm prints, iris or retina patterns, and voice patterns, to identify individuals through a verification process. The most widely used example may be India's national ID program (Aadhaar), which is the largest biometric database in the world. Aiming to cover all 1.25 billion citizens of India using biometric data (e.g., fingerprint, iris scan and facial recognition) and demographic data (e.g., name, age, gender, address, parent/spouse name and mobile phone number), it is currently used by 550 million residents to engage with public services from local and national government agencies.[18] Several other governments also use biometric scanners to oversee immigration and elections, businesses use the technology for secure access to facilities, hospitals for protecting patient information and even some humanitarians have incorporated biometric scanners to manage refugee camps.

Security has been driving the growth of biometric tools. Institutions can control access, track movements and protect assets by verifying authorized people's physical traits, which are less likely to be forged than other forms of identification. Users reported finding great value in using the systems maintained by public and private institutions, but few have found it practical to own a biometric scanner for personal use. The costs can be prohibitive for ordinary citizens and their needs rarely require systems as robust as those currently on the market. Today's industrial scanners are supported by specially trained personnel as well as additional systems and services designed to manage large populations and their data. Even seemingly simple biometric scanners like the fingerprint recognition systems on computers and smart phones, required years of specialized software development and dedicated hardware interfaces.

Furthermore, all biometric devices require the following:

- A person to register with the system
- The biometric data to remain consistent and unique to one user
- The system to read biometric data reliably
- Computing technology robust enough for near real-time authentication of the biometric data

Unfortunately, not all of these attributes can be achieved at the same time via current biometric systems. For example, recent experiences in using biometrics for voter registration and voting processes in Nigeria and Kenya, experienced multiple hardware, software and human errors. In the near future, however, as the technology is perfected and users become more practiced, biometric scanners will help to streamline and personalize services, establish an accurate population count, reduce duplication, impose accountability, and provide formal identity and rights to those currently unrecognized.

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[17] Most of the expense is in the development and maintenance of the application and assumed by the software owner.

[18] The Evolution of India's UID Program: Lessons Learned and Implications for Other Developing Countries, Center for Global Development (August 15, 2012) – See more at: http://www.cgdev.org/publication/evolution-india%E2%80%99s-uid-program-lessons-learned-and-implications-other-developing

During the regional consultations, community members and experts were divided in their feelings about biometric scanners. Participants agreed biometric scanners would be useful tools to manage relief distributions and cash grants, find and reconnect separated families, and restore lost documentation. Community members appreciated that biometrics could help them fight false criminal accusations and prove their identity more immediately than DNA testing. Residents of Nairobi, Kenya's informal settlements, in particular, envisioned that biometric scanners could help improve their living situation. With proof of identity, they could gain access to financial services as well as have a greater understanding of their community's size and demographics to advocate for additional resources and responsive policies.

That said, community members also noted some drawbacks to the technology, including potential abuses of power, privacy breaches and fraud. Some residents did not want to be tracked, traced or profiled by the government. In response, community members universally requested that a trusted, third-party manage and protect their data; neutral humanitarian organizations were recommended to serve as brokers. During the dialogue, participants also noted that if nongovernmental organizations play this role, data transfer protocols will need to be established between them and states to ensure national and international coverage.

Others involved in the dialogue worried that if the system failed, they would be denied access and benefits. This was particularly true of those who may have cataracts or are missing fingerprints. Redundant methods of scanning would help reduce this potential and remove some of their concerns about using biometric scanners in the future, they noted.

These and other discussions showcased relatively low levels of data literacy among the disaster survivors involved in the dialogue. Most of the community town hall participants, for example, lacked understanding of basic data principles and practices, and depending on mass media and other influences, they either expressed ignorance and vulnerability or suspicion and rejection of today's data management systems. It is important to note, that regardless of their location in the world, people have an expectation of data privacy and security. Even if they are willing to trade on it temporarily post-disaster, we must not take advantage of their vulnerability.

Robots
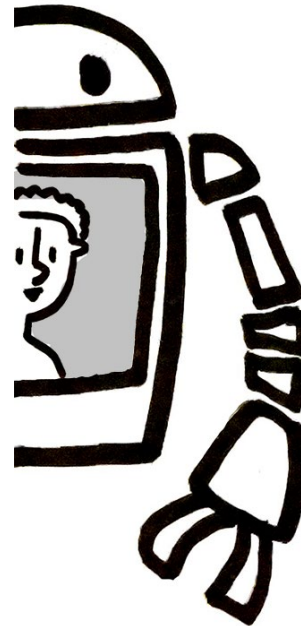
Robots are machines instructed to perform tasks by computer programs, autonomously or semi-autonomously. They can range from industrial robots that do one specific task, such as installing parts on a vehicle assembly line, to humanoids, such as Honda's Advanced Step in Innovative Mobility (ASIMO) robot that can walk on two legs, recognize humans and voice commands, and autonomously interact with items in its environment. In the past several decades, robots have been used to:

- Move and assemble items.
- Search for and rescue disaster victims.
- Perform acts of service and inspections.
- Teach and solve problems.
- Fight battles.
- Guard buildings and borders.

Robots are often used in industry and scientific exploration where tasks are too dangerous, mundane or physically impossible for humans, such as in bomb disposal or deep-sea exploration.

Automation is a key factor in the rise of robots. Society is looking for easier and faster ways to accomplish more things. The once secret projects of governments are now the pet projects of several Fortune 500 companies. Several experts agree that robots will be the "the next big thing" after the mobile era ends. In 2013, Bill Gates, former Microsoft CEO, said publicly that robots and other automated technologies will have an exponential effect on society and likened their potential to the personal computer. Robotics is expected to become a $70 billion USD industry by 2025.[19]

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[19] The Next Big Thing After Mobile, Business Insider (April 6, 2012) – See more at: http://www.businessinsider.com/whats-the-next-big-thing-after-mobile-2012-3

Robots, for example, are already supplementing emergency healthcare. Highly contagious diseases, like Ebola, can spread rapidly in urban environments and the volume of medical needs can strain the healthcare system. To add to the complexity, there is already a worldwide shortage of trained healthcare workers. Responding to epidemics also puts healthcare workers at significant risk of infection. Robots, with video screens to display the faces and voices of human healthcare workers, can provide diagnostic support, treatment and monitoring of medical patients. They can also assist nurses and doctors in removing their personal protective equipment, in burying the deceased, and in comforting people who are suffering from stress and trauma. While people are in quarantine, robots may also deliver medicines, basic necessities and video communications from loved ones.

Like other emerging technologies, robots also have an image problem—one manufactured by the entertainment industry. Robots were featured in radio, television and films since each was invented, and in popular books even before then. While robots have generally been portrayed positively, their negative roles are prominent. With the global reach of modern Hollywood, most urban residents have a mass media-influenced perception of robots' capacity that often greatly exceeds their current capacity. That said, dialogue participants in Seoul, South Korea, were significantly more comfortable with and accepting of robots; some even owned household robots. There, government and commercial marketing initiatives had normalized these tools, set realistic expectations and overshadowed other influences.

During the dialogue, community members and experts in other countries struggled to find the consumer value in robots based on their pre-conceived notions. They believed institutions, such as firefighting units and hospitals, would find greater benefit to their operations. They based this recommendation on the fact that most community members do not possess the skills or time to program and operate robots. They acknowledged, however, that their skill levels may evolve over time, similar to how they learned to use personal computers, mobile phones and social media as they were introduced. They also anticipated that in the future, consumer robots would have simple remotes or be controlled by applications on a mobile phone or tablet.

The most common use cases for robots to assist with strengthening urban resilience, according to the dialogue participants, included supporting telepresence, psychosocial counseling, medical treatment, search and rescue, and clean-up assistance. Robots were seen as having the greatest value add when the human user could not be somewhere because of financial or physical limitations. Robots, they said, must possess powers humans would not otherwise have to prove their worth, and they must display a real human face and voice to be trusted.

The list of drawbacks, however, outweighed the participants' nascent interest. Most could not imagine being able to own a robot, although in truth, some robots are no more expensive to own than a computer. Even the most expensive robots are on par with the cost of the most expensive unmanned aerial vehicles, and they could easily be shared or accessed through a fee-for-service model.

They also raised concerns about the robots' durability. Many of the robots that are under development by government and academic labs are still too delicate for everyday use. Commercial robots that assist with household chores are a bit more rugged, but they are also designed to operate indoors with limited stimuli, and many require direct human control to move about in real-world environments.

Some also questioned the trustworthiness of robots, asking if they would betray the programmer/user. Others felt robots may pinch jobs from first responders and construction workers, and they did not want robots to become a substitute for human contact and knowledge. These barriers—ranging from perception and trust to technical abilities—will need to be addressed by developers before the average consumers will embrace them as helpful resources.

Smart Cars

Smart cars are generally understood to be autonomous and semi-autonomous human transportation vehicles, but they can also include routine enhancements that make the vehicles safer and more connected. Some can sense their environment and navigate without human input, fulfilling the transportation capabilities of a traditional car or public transportation. They can range in capacity from the European Commission's Intelligent Car Flagship Initiative that seeks to develop cars with autonomous cruise control, to lane departure warning systems, Project AWAKE for drowsy drivers, and the self-driving car Google is developing to navigate autonomously from start to finish on normal city streets.

Autonomous vehicles sense their surroundings with such techniques as radar, lidar, GPS and computer vision, with advanced control systems interpreting sensory information to identify appropriate navigation paths as well as obstacles and relevant signage. Even semi-autonomous cars can perform tasks like changing lanes at high speeds or parallel parking on city streets without human input.

Smart cars hold interesting potential for strengthening urban resilience, in that they can also operate on sustainable fuel sources leading to positive environmental implications, expedite safe evacuations before and after

emergencies, and receive messages and alerts based on risks in its surroundings. Dialogue participants also noted their ability to float in flooding disasters. Community members, who do not own or use personal vehicles, expanded the use cases to include making public buses (e.g., "matatus" in Nairobi, Kenya) smarter to increase their day-to-day safety and allow them to be utilized in a major disaster response. That said, smart car engineers have been cautious in considering their potential emergency applications given the technology is slow to develop and only just beginning to display signs of success.

Overall, smart cars did not resonate with the dialogue participants. The most significant barriers centered on cost and liability. Today's smart cars are typically more expensive than other models in the marketplace given their enhanced features. Some community members commented that since they did not own a car, nor expected to own one soon, that the technology did not seem relevant. However, they intuitively understood the smart bus concept and were proponents of public transportation adopting many of the smart car technologies.

The next barrier will need to be resolved through policy. In many countries, drivers of semi-autonomous vehicles are held responsible if their vehicle hits another or causes another type of accident, yet responsibility for fully autonomous cars is still being debated. Policymakers have not decided if the driver, the manufacturer or the programmer will be held liable when a smart car causes injury or damage. The fear of litigation is strong enough to keep some dialogue participants from exploring smart cars.

Finally, while smart cars can navigate autonomously, they perform best when a visualization of their intended path has been programmed into the onboard computers and is still accurate when the car is sent on a mission. Participants noted that after a disaster, when the landscape changes dramatically, updated maps would need to be available immediately to effectively utilize smart cars for a response.

Smart Home Sensor Networks

Smart homes generally refer to residential structures with a high level of automation and interactivity between electronic and mechanical systems, such as the following:

- Home entertainment systems
- Lighting
- Heating, ventilation and air conditioning
- Appliances
- Security systems (door and window locks and alarms)

These devices are increasingly controlled remotely by voice or applications on smartphones and tablets. Smart offices is a similar concept applied to business venues.

Smart home technology can improve convenience, comfort, energy efficiency and security of a home or just provide an increased quality of life. Smart homes are often adjacent to "Internet of Things" discussions and futurism, where every electronic device in a home can be controlled remotely, or communicate with other devices, via the Internet. One often-cited idea is a medicine cabinet automatically communicating with a pharmacy to have its contents restocked when they run low.

Other advances in smart home technology include monitoring children, displaying virtual art upon the walls, feeding pets, broadcasting alerts and maintenance reminders, measuring air quality, and detecting seismic activity, water levels and fires. Smart home sensor networks also have the ability to send and receive messages based on user-generated triggers.

Today's smart homes systems can range from extremely simple to notoriously complex. The main limitation to bringing these flexible systems to scale is they are not yet interoperable. In addition, many of the current smart home solutions are perceived as luxury goods, and not fulfilling a high-demand need. For these reasons, smart home technology was only moderately attractive as resilience-strengthening solutions to community members and experts engaged in the global dialogue.

Community members were significantly more excited by the idea of a home or office building with sensors for fire, earthquake, gas leaks and even pollution, as opposed to the more convenience or entertainment-related use cases. They also preferred the use cases that involved disaster-resistant technologies, such as computer-controlled wind and water barriers that would protect a home's interior from damage. They requested that these solutions be programmed to alert the building's occupants and emergency responders when a risk presents. They also desired the smart homes to automatically take time-sensitive action, such as turning off the gas or bracing the roof for high winds. Some dialogue participants also saw the added safety benefits and would enjoy being able to assess disaster damage remotely and alert authorities in the case of an intruder.

But they also saw several downsides, including the potential for security breaches or hackers taking over control of their homes. And most participants questioned the utility of these high-tech features for resilience-strengthening. They worried that the automation would lead to over reliance on computers, which would not likely work in an emergency. Community members also showed concern that they could erode traditional coping skills and make people "lazy." Finally, they noted that disasters commonly disrupt electricity and homeowners would need alternative ways to access and operate in their homes during those periods. To make smart home sensor networks most helpful for disaster-prone, urban communities, developers will need to address these and other barriers.
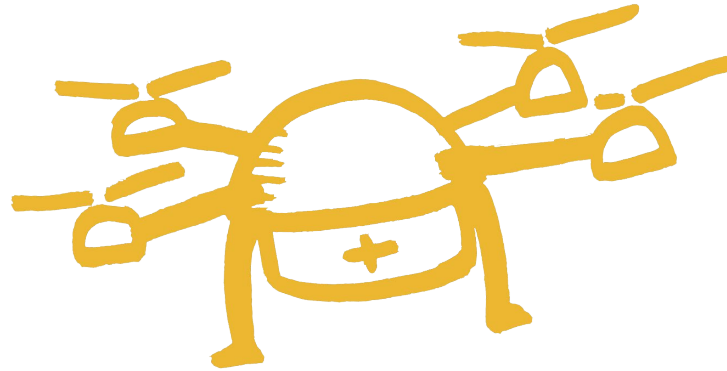
Unmanned Aerial Vehicles

Unmanned aerial vehicles (UAVs), commonly known as "drones," are remotely piloted aircrafts or those that are flying autonomously on a programmed route. They can range in size from small helicopters that can fit in the palm of a hand to full-sized, fixed-wing planes. And they can use any number of sensors, from visible light to infrared as well as air and water sensors, in their missions. They are typically assigned flying tasks that are too "dull, dirty or dangerous" for manned aircraft.[20]

UAVs are most notably used by military forces for aerial reconnaissance, but there are a myriad of civilian uses, from photographing real estate to monitoring livestock, pipelines and wildfires; and delivering needed supplies. Amazon Prime Air and Matternet are two examples of the latter. They are developing UAVs to deliver goods weighing up to five pounds (2.3 kilograms) over a 30-mile (48 kilometers) range.[21]

In recent years, several humanitarian organizations and governments have used UAVs in disaster management, most notably for assessing vulnerabilities before an emergency and damage after the disaster. Conservationists and farmers also utilize UAVs to track animals as well as the poachers and predators who hunt them.

Professional-grade UAVs can require a significant financial investment for communities; however, when compared to satellite imagery they are less expensive and more precise. As with 3D printers, the cost and size of UAVs is dropping quickly, while the capacity of their payload size and type is increasing just as fast. Until recently, UAVs have been largely unavailable to stressed populations, but creative minds in Latin America have found ways to assemble low-cost, balloon-style drones using trash for a fraction of the cost. They are also becoming increasingly rugged and safer, diminishing some concerns of the past.

Yet, the technology is still in its infancy, and regulations have not kept pace with UAV innovation, including safety regulations, licensing, insurance and training protocols. Air space control has led to sweeping bans in some countries and small-range restrictions in others. In many contexts, UAVs must remain within the line of sight of the operator during the flight, for example. Crossing borders for trade also presents political and economic challenges that have yet to be resolved.

UAVs also have an image problem. They are still closely associated with their military use, and are seen by some as weapons. As a result, the United Nations Office for the Coordination of Humanitarian Affairs has issued guidelines on the use of UAVs in humanitarian efforts, discouraging their use in post-conflict settings.[22]

Still, UAVs have been well received throughout the dialogue. And although the issues surrounding them are becoming more complex, they are revolutionizing the options for data collection, trade and agriculture. Both community members and experts involved in the dialogue agreed on their value as quick delivery agents for high-value supplies, such as medicines, and the sky as a temporary supply route in early response activities, as UAVs could traverse terrain that might be impassable otherwise. They also appreciated their potential to supply lighting, power and connectively from the air until more permanent solutions on the ground can be restored post-disaster.

One recurring theme from the global dialogue was UAV ownership. Community members did not express high levels of trust in government or private industry owning and operating drones for the public's benefit. They were more comfortable with community ownership and management of UAV technology. With the rapidly decreasing cost and skills needed to fly UAVs, local community groups can and do own UAVs today, including disaster survivors in Haiti. Like 3D printers, robots and smart cars, UAVs were also considered ideal products for sharing economies.

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[21] Why our drone future is for real—someday, C/Net (December 16, 2014) – See more at: http://www.cnet.com/news/why-our-drone-future-is-for-real-someday/

[22] Unmanned Aerial Vehicles in Humanitarian Response, United Nations Office for the Coordination of Humanitarian Affairs (June 2014) – See more at: https://docs.unocha.org/sites/dms/Documents/Unmanned%20Aerial%20Vehicles%20in%20Humanitarian%20Response%20OCHA%20July%202014.pdf

Wearable Devices

Wearable technology comprises clothing and accessories incorporating computer and advanced sensors, such as armbands, body cameras and glasses. As the cost and size of the sensors continue to decrease, they are being incorporated into more items and expanding the type and use of wearable technologies to textiles, shoes, hats, rings, stickers and contact lenses.

One of the most common forms of wearable technology is the human activity tracker. Devices like the Fitbit can track and provide real-time feedback on a person's movements and calories, and more advanced wearables can even monitor heart rate, blood pressure and location in real time. Usually paired with a mobile phone, activity trackers are disrupting how people measure themselves and regulate their health. For the first time, we can know how someone feels without proximity thanks to these wearable sensors.

Wearable technology is distinct from other mobile technologies, like phones and tablets, because it has enhanced features that require it to be worn as a "hands-free" device. Because they are attached to the body, they are also less likely to become separated in a chaotic situations than mobile phones and other devices that are carried. In this vein, wearable technology associated with glasses, like Google Glass, or watches, like Apple Watch, are more nascent, but have the potential to transform the smartphone from a handheld device to one integrated into worn items. They also bring new possibilities to human-computer interactions, such as biometrics-aided, facial recognition with glasses, health monitoring with clothing, and early warning with wristbands. Interesting uses cases generated through the dialogue also included wearable beacons to aid search and rescue, shoes to sense earthquakes, wristbands

to find and communicate with loved ones if separated, and eyewear that integrates augmented reality software for real-time translation and navigation.

This emerging technology was the most prioritized tool for resilience strengthening during the dialogue. Community members and experts all recognized the value of wearable technology transmitting location information, which could be used by first responders to find people and accelerate family reunification after an incident. They also envisioned wearable technologies assisting with medical triage and diagnosis; this use could also help prevent disease transmission if healthcare professionals can access the patient's information remotely. Others expressed interest in wearable technology for their pets as well.

Cost was not perceived to be a major barrier, given that wearable devices are among the least expensive of the eight technologies explored in the dialogue. Participants also stated that they had the most relevance in everyday life and met all of the other criteria for resilience-strengthening solutions.

While the benefits far outweighed any concerns, dialogue participants noted a few barriers, which, if resolved, would increase their value immensely. Today's activity trackers focus on movement, but do not give a full picture of the user's health, which can lead to skewed priorities and outcomes. Additionally, computer-aided glasses can create a perceived or real barrier between the user and society as a whole. Participants noted that it is important not to eliminate all human interaction simply because technology does not require it; social cohesion is critically important to resilience. They also said that wearable devices could create additional distractions that impair driving and other activities.

Participants noted that both glasses and trackers currently require smartphones and Internet access, which limits their disaster use. Some even expressed mild concern that, like mobile phones, scientists do not yet know the long-term health effects of wearing electronic devices. Lastly, these technologies also raised privacy and ethical issues for community members and experts alike. They agreed that they would like options for how their information is shared and with whom, noting they may opt in to sharing the information with the doctor but restrict government and insurance company access.

The following table summarizes the emerging technology solutions that participants in the community town halls reported being the most and least comfortable using. The order in which they are presented reflects a weighted vote.

July—December 2014	Most Comfortable/Useful, According to Community Members		
Seoul, South Korea	Robots	Wearable Devices	Augmented Reality
La Plata, Argentina	3D Printers	Unmanned Aerial Vehicles	Wearable Devices
Nairobi, Kenya	Biometrics Scanners	Wearable Devices	3D Printers/Smart Home Sensor Networks
Cork, Ireland	Wearable Devices	Unmanned Aerial Vehicles	Biometric Scanners[23]
San Francisco, United States	Unmanned Aerial Vehicles	Wearable Devices	Smart Home Sensor Networks
Global Consensus	Wearable Devices	Unmanned Aerial Vehicles	3D Printers/Biometric Scanners

July—December 2014	Least Comfortable/Useful, According to Community Members		
Seoul, South Korea	Unmanned Aerial Vehicles	3D Printers	Biometric Scanners
La Plata, Argentina	Smart Cars	Smart Home Sensor Networks	Augmented Reality
Nairobi, Kenya	Smart Cars	Robots	Augmented Reality/Unmanned Aerial Vehicles
Cork, Ireland	Augmented Reality Software	Smart Cars	Biometric Scanners
San Francisco, United States	Augmented Reality Software	Smart Cars	Biometric Scanners
Global Consensus	Smart Cars	Augmented Reality Software	Unmanned Aerial Vehicles

The global dialogue revealed a great deal of optimism and anticipation for emerging technologies, as well as several issues that need to be resolved before they can be effective as resilience-strengthening applications. The Red Cross and Red Crescent urges the makers and users of emerging technology to conduct additional participatory design sessions as they refine and adapt the current prototypes to find the optimal solutions to address people's emerging needs and barriers to resilience. To ensure widespread adoption and encourage future innovation, it will be essential to take the insights and recommendations of the community members into account.

[23] Participants in the Cork community town hall were divided in their optimism and concern for biometric scanners.

Recommendations

Throughout the dialogue, communities and experts shared their advice and priorities with the Red Cross and Red Crescent. Their sentiments serve as formal recommendations to assist technologists, business leaders, governments, researchers and nonprofits in realizing emerging technology for emerging needs. The Red Cross and Red Crescent urges these actors to take note of the following five commonly shared requests from across the globe, ranging from the way technology solutions are introduced to the most desired humanitarian use cases.

1. Engage local community members in the design, manufacturing and introduction of new technology solutions.

Too often, design decisions are made without incorporating user priorities, values, traditions and attitudes. Some solutions will not be accepted by users, nor will they be appropriate for certain communities or disaster scenarios. Engaging communities in all stages of development ensures that users have input to the decisions that impact their lives. In addition to meeting people's universal need to be heard, seen and understood, this approach leads to greater acceptance and value among users, and, ultimately, it leads to fewer mistakes and saves businesses time and money. Participatory design and implementation also leads to greater brand loyalty and more enduring, sustainable solutions. Furthermore, dialogue participants recognized the added economic benefits that result when the solutions are manufactured locally. When an entire ecosystem of stakeholders is part of the preparation, creation, implementation and evaluation of an idea, everyone is accountable and successful.

Dialogue participants recommend that nonprofit organizations and businesses help communities translate their needs and values by creating opportunities for local experimentation with emerging technologies before they are commercialized. For example, the Red Cross and Red Crescent is exploring preparedness workshops that teach technology skills and is considering the inclusion of emerging technology prototypes in disaster response kits for experimental use by affected community members during late response and early recovery periods.

2. Support consumer access, management and ownership of emerging technologies.

Today, many emerging technologies are perceived to be too expensive for most individuals, especially those living in low-resource communities, to own. Cost alone should not prevent access and management, according to the dialogue participants. History suggests that the prices will continue to fall, and ownership of these tools may achieve the same ubiquity and cost-effectiveness as mobile phones over the next decade. As developers consider how to maximize the products' impact, the dialogue participants suggest that implementing differential pricing, low-cost or free devices in exchange for data, and other schemes can ensure greater access. When the market allows, local enterprises can also support the distribution and maintenance of these emerging technologies. In the meantime, people are able to access and manage emerging technologies for a small fee per use, as a membership benefit or at no cost at all through public, private and peer networks. 3D printers, for example, are increasingly available to the public at libraries, community labs, universities and retail copy shops. Private companies are offering leases for unmanned aerial vehicles and robots at hourly and daily rates, and smart cars are commonly available for rental in urban communities via sharing economies as well. Other business models, including subsidies, circular economies and service plans, can offset the initial investment for low-resource urban communities. In addition to the cost savings that result from these networks, users benefit from training, regular maintenance and insurance.

3. Research the impact of technology on community resilience.

At various points throughout the dialogue, participants raised questions about society's assumption that technology positively impacts resilience. Anecdotally, both community members and experts shared examples of ways technology may have replaced traditional coping skills and the challenges people experienced when technology was not available during emergencies. The Red Cross and Red Crescent recommends a deeper examination of how technology aids and detracts from a community's capacity to effectively manage crises, possibly using the Haiti earthquake, Superstorm Sandy and Typhoon Haiyan as case studies given the prevalence of and reliance on technology in those situations.
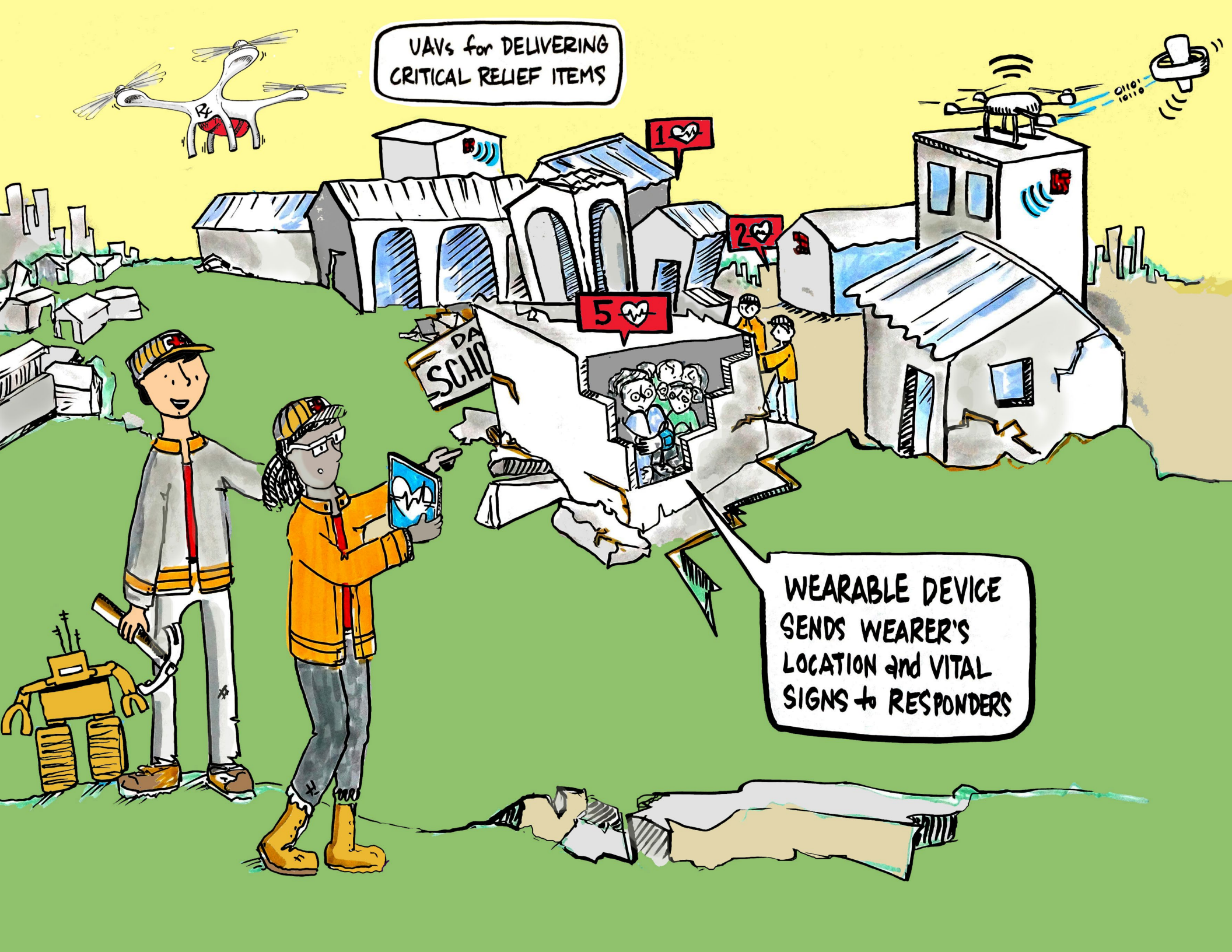
4. Establish supportive policies, systems and guidance for the development and use of emerging technologies.

To secure the confidence of individuals and communities, technologists, governments and humanitarians must take a balanced and principled approach to their development and use. First, community members need to know when official institutions and outside groups are using emerging technology in their area. Advanced notification, as well as the opportunity to influence and participate in plans, is important to community members, and the addition of their local knowledge will make the plans more efficient, appropriate and sustainable. Additionally, participants shared their desires to see clear and consistent protocols for technologies that collect and receive data, agreement on how the data is used and by whom, and consequences for its misuse. Dialogue participants recommend that stakeholders form a coalition to develop global codes of conduct based on these types of community considerations to guide their approaches and inform local and national policies. They noted the value of using community demand and humanitarian evidence to address where governmental policies are lagging, such as 3D printers, and where strict regulation may be hindering the humanitarian use of emerging technologies, such as unmanned aerial vehicles.

5. Invest first in four emerging technology use cases that address actual barriers to resilience.

Out of the thousands of use cases debated through the dialogue, the following emerging technology solutions were prioritized based on their capacity to strengthen users' capacity to cope with emergencies and address specific and recurrent issues that delay or prevent a community's recovery. Experiments in supportive environments will assist in proving these concepts further, expanding their use to support other interests and behaviors, and otherwise meeting the criteria for resilience-strengthening solutions.

Wearable devices for providing early warning, supporting search and rescue, and reconnecting families post disaster
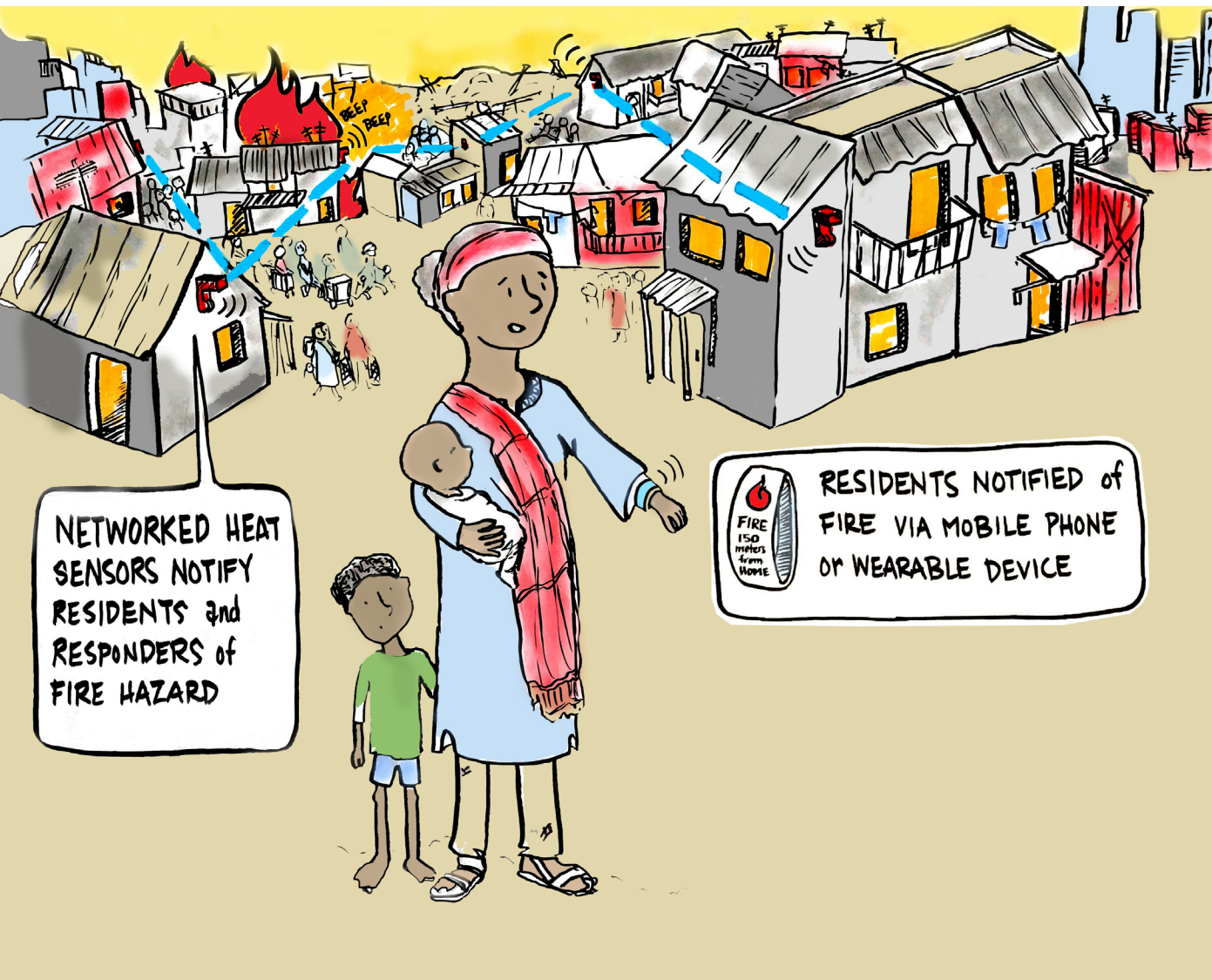
Important preparedness messages and the early warning of disaster risks often arrive too late, are misrouted and overlooked, and sometimes they never arrive. Loss of life, injuries and property damage could be avoided with timely, accurate and actionable guidance. Mobile devices and push notifications have helped to close the gaps in recent years, but as consumer behavior changes and applications become more cumbersome, officials need to consider more effective ways to send and receive early warning to citizens, especially those who may have visual or hearing impairments. Additionally, when disaster strikes, people can easily become trapped in buildings or asked to shelter in place for a significant period of time. If left in these situations for too long, without food, water and medical care, lives will be lost. Families can also suffer psychological and emotional stress, if separated. During this time, first responders will receive an overwhelming number of calls for help, but it is nearly impossible to respond without GPS data and verification of the need. It is critically important the first responders prioritize and target their efforts, especially when resources and time are limited.

Proposed solution: A wearable device that receives preparedness messages, early warnings and advice from officials; sends the wearer's location and vital signs to emergency responders to aid in search and rescue; displays the location of other family members; and allows two-way communications with emergency responders and loved ones. The wearable device could be sold commercially to outdoor enthusiasts in order to subsidize at-risk communities' use.

Unmanned aerial vehicles for temporarily restoring communications networks and delivering critical relief items, such as medicines, post disaster

Telephone and Internet communications are a critical need in emergencies, and yet they are typically disrupted in major disasters. It can take several days and weeks to restore infrastructure and services, and during this time, few people have access to information, ways to contact their families and the tools they need to jumpstart their recovery. Natural disasters also can quickly and indiscriminatingly isolate communities, restricting ground transportation and access by first responders and suppliers. It is not uncommon for communities to become cut off from food, water, communications and health care in emergencies. And it can sometimes take weeks and months to clear debris, open roads and restore the flow of assistance.

Proposed solution: A swarm of unmanned aerial vehicles (UAVs) that transmit mobile and Wi-Fi signals using a mesh network for a localized area to restore critical communication for citizens. The aerial vehicles can hover in the air or land on tall buildings/mountains, and citizens can contact family members, employers and service providers via an application or SMS without overloading the system. Additionally, unmanned aerial vehicles can deliver small items, such as power sources, lighting, life jackets and medicines to targeted groups of people. The aim is to improve the response time for isolated and inaccessible communities, and the UAVs can be pre-tested and kept on standby for rental by community groups.

NETWORKED HEAT SENSORS NOTIFY RESIDENTS and RESPONDERS of FIRE HAZARD

BEEP BEEP

FIRE 150 meters from home

RESIDENTS NOTIFIED of FIRE VIA MOBILE PHONE or WEARABLE DEVICE

Smart home sensor networks for sensing and reporting fires in informal settlements/slums

Fires regularly occur in urban slums, sometimes because stoves are used indoors, wires are faulty or residents are trying to keep warm. Rapid and haphazard development forces homes close together and allows fire to spread easily. Pathways between homes are narrow and often blocked. The density of the slum makes evacuations chaotic and dangerous. Residents commonly do not know who to call for firefighting assistance. And traditional firefighters, if they are even available, have a difficult time finding and responding to these fires quickly. Residents are therefore left devastated and homeless.

Proposed solution: Low-cost, smart home sensors that are solar-powered and affixed to each home within the informal settlement. The sensors are networked to each other using radio signals and they can detect a fire early, distinguishing between smoke and fire, and sound alarms across the network via SMS and broadcast to alert nearby homeowners. They can also directly notify firefighters (or an informal brigade of citizen volunteers) and provide GPS data for the location of the fire. Armed with current maps, the firefighters can effectively reach the fires in time to save lives and property. This use case was particularly attractive to local entrepreneurs, who believed that homeowners and renters would be willing to purchase these safety devices outright.

Biometric scanners in ATM-like kiosks for restoring lost documentation to prove identity, access assistance and reconnect families.

It is very common for families and businesses to lose personal documentation, such as identification, proof of residence or home ownership, insurance policies, and medical records, in an emergency. It is also nearly impossible to start the recovery process without this documentation. Even after government services and businesses have resumed, they may not reissue the documentation without proof of identity. Under these circumstances, disaster survivors can be left in limbo for months or years. Additionally, sudden disasters can cause families to become separated. Sometimes just across town and other times across borders. Not knowing where your loved ones are, if they are okay and when you will be able to reconnect can be incredibly painful. When the lack of communication and transportation makes it challenging for families to connect in emergencies, they turn to the Red Cross and Red Crescent for assistance. As people arrive at shelters, refugee camps and other safe places, they register their location, and the Red Cross and Red Crescent can consult multiple databases and resources to locate missing loved ones.

Proposed solution: Solar-powered kiosks, at which people scan their fingers and eyes using biometric technology. In non-disaster times, the machines dispense cash like ATMs, and in emergencies, they can also be used to retrieve personal documents from the cloud storage and print replacement identification and other important documents (similar to self-service boarding pass kiosks at the airport). They may also be used to collect grants to restart businesses and locate family members who may have registered with the Red Cross and Red Crescent or another trusted organization. The kiosks would be owned and maintained by private businesses, such as financial institutions, or government agencies, and individuals could access them at no charge in emergency situations.
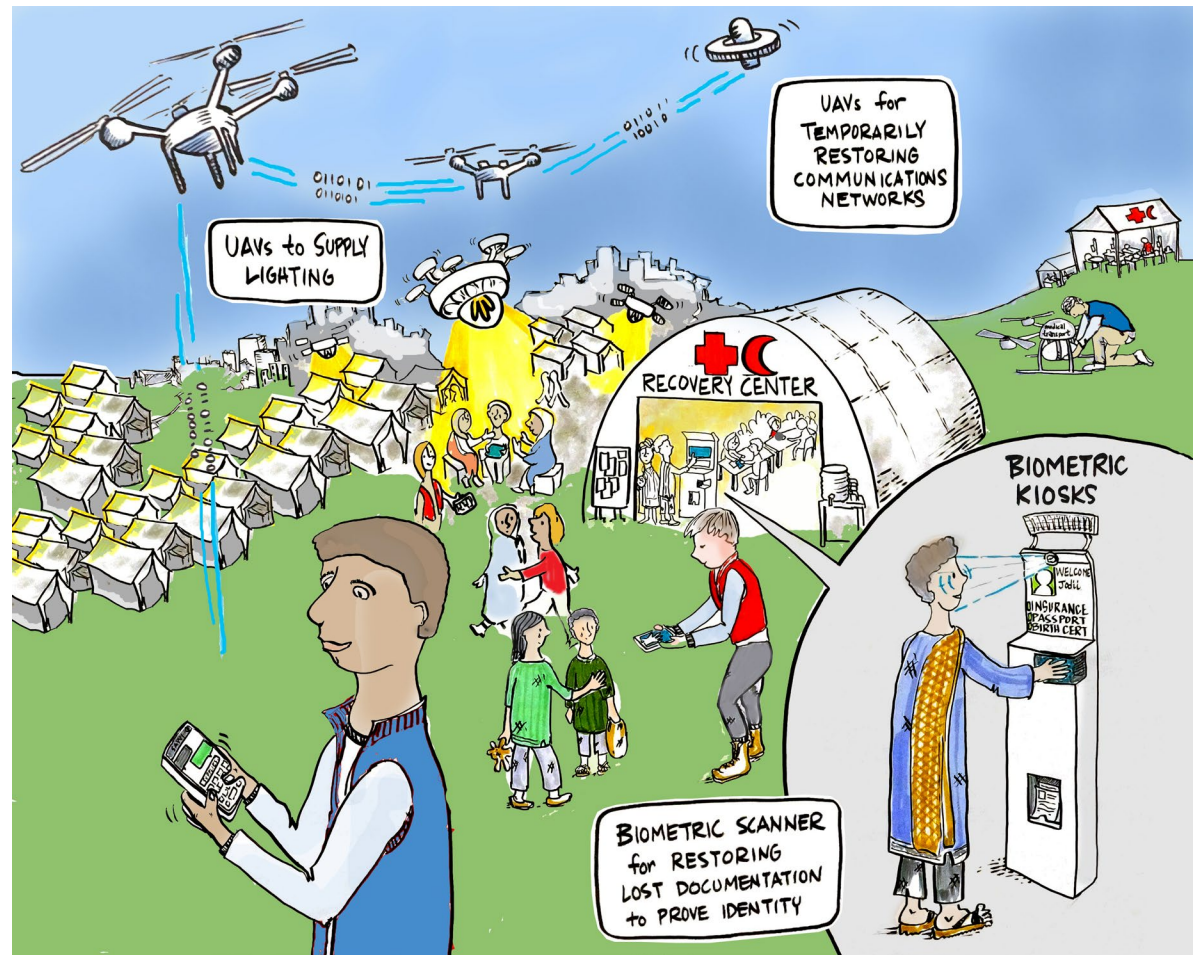
Conclusion

In early 2015, the Red Cross and Red Crescent began transitioning the exploration in emerging technology from dialogue to experiments. Together with our collaborators, we are reengaging urban communities in designing and managing four short-term field demonstrations and pilot projects to prove the concepts prioritized through the dialogue. Innovation teams, composed of multi-sector volunteers, will establish the ideal technical specifications, make the necessary technological adaptations and develop applications to support the prioritized use cases. The four agreed-upon areas of initial focus include:

- Wearable devices for providing early warning, supporting search and rescue, and reconnecting families
- Unmanned aerial vehicles for temporarily restoring communications networks and delivering critical relief items, such as medicines, post disaster
- Smart home sensor networks for sensing and reporting fires in informal settlements/slums
- Biometric scanners in ATM-like kiosks for restoring lost documentation to prove identity, access assistance and reconnect families

Throughout the next two years, we will assess the initial impact of these emerging technologies on urban resilience and share our insights with urban community leaders, technology and policy makers, our peers and other stakeholders to inform how these novel tools are adapted and scaled for consumers over the next decade. Ultimately, our collective learning will help shape the future of humanitarian action, close the digital divide and improve the disaster resilience of 1 billion people worldwide by 2025.

To achieve these ambitious goals, the Red Cross and Red Crescent will need the support of a coalition composed of technologists, business leaders, government officials, researchers, policy experts, nonprofits and others. Strengthening resilience, and society as a whole, is not the responsibility of one sector or one organization. Resilience is the bridge between humanitarian and development interests, and the "horizontal" theme that unites several "vertical" specialties, including education, health, economic development and the environment. The more than one thousand participants in the dialogue fully recognize the interdependence of strong communities and strong economies, and noted its place as an imperative area to create shared value.

To advance these ideas and remove the barriers to resilience, each sector will need to devote its specialized expertise as well as resources of time, funding and unique products and services. And to meet the growing global demand for innovative tools and approaches, we also will need to coordinate our work, identify additional collaborators and leverage each other's strengths.

The teams formed around the four prioritized use cases, for example, have already identified an initial list of ways community leaders, product developers, policy makers and funders can support a field experiment:

- Build trust with local community members. Identify local networks to participate and help educate them.
- Donate and adapt hardware solutions. Develop more durable hardware with greater battery life and innovative power sources.
- Design applications and ensure interoperability with existing systems. Volunteer time to build, secure, test and maintain solutions.
- Develop data collection and transfer protocols. Refine regulations to support civilian use and offer affordable training, licenses and insurance.
- Advise on the local market, appropriate price and financing schemes, as well as the security and legality of solutions.
- Prioritize funding for experimental technologies and research.
- Advise on the implications for emergency responders, businesses and other stakeholders.

In sharing responsibility, we encourage the private sector, in particular, to invest in low-resource populations upfront rather than waiting to address their needs after primary markets are saturated. When technology companies and entrepreneurs collaborate with humanitarians they can gain important information about the users and their environment. These trust brokers can also help secure community participation and achieve scale through their local networks.

Throughout the next phases of the initiative, the Red Cross and Red Crescent and its collaborators will share their learning through public speaking engagements, publications and other forums with the aim to shape the future of humanitarian action and measurably improve disaster resilience worldwide.

Learn more at **tech4resilience.blogspot.com**.

Acknowledgments

"A Vision for the Humanitarian Use of Emerging Technology for Emerging Needs" was made possible with support from Accenture, American Red Cross, Argentine Red Cross, British Red Cross, Buenos Aires Institute of Technology, GSMA, IDEO, International Committee of the Red Cross, International Federation of Red Cross and Red Crescent Societies, Irish Red Cross, JPMorgan Chase & Co., Kenyan Red Cross, Korean Red Cross, Kurante, Motorola Solutions Foundation, Netherlands Red Cross, Nyenrode Business University, Red Cross and Red Crescent Climate Centre, Red Cross and Red Crescent Global Disaster Preparedness Center, Stanford Center for Philanthropy and Civil Society, Texas A&M University, Twitter, United Nations Office for the Coordination of Humanitarian Affairs, World Bank and World Economic Forum, along with the many community town hall and expert workshop participants.

This report serves as an official submission to the World Humanitarian Summit.

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