Telecommunications and disaster management:

Participatory approaches and climate change adaptation

Marta Poblet
RMIT University

Hartmut Fünfgeld
RMIT University

Ian McShane
RMIT University

Summary: This paper offers an overview of participatory approaches to disaster management and climate change adaptation as an introductory framework for the following five papers on the special theme of telecommunications and disaster management. While climate change is considered a societal challenge of global proportions, its impacts on human population and ecosystems take place at the local and regional levels. The geographic coordinates of disasters and emergencies, therefore, call for different location-based strategies that are embedded in their social and ecological context. Affordable, bottom-up, networked telecommunications meeting these conditions can be part of these strategies. The following papers in this issue offer a number of concepts, cases, and potential solutions.

Introduction

By the end of 2014, the number of active mobile phones will have reached 6.9 billion, approaching the number of people living on our planet (ITU 2014). By 2018, there could be 1.4 mobile phones per capita, in addition to a rapidly growing number of tablets, navigation systems and other mobile telecommunications devices (CISCO 2013). In the Australian context, recent research has highlighted that, following a global trend, communication services delivered over the top of the telecommunications network (OTT)—VoIP and mobile messaging applications such as Whatsapp, Snapchat, Viber, Line , and Facebook Messenger,—are increasingly used as alternative sources to carriage services (ACMA 2014). This trend enables consumers to "build their own communication links" by choosing "a different option if one service is not working, effectively building additional redundancy and robustness through self-management of their communications network and service access" (ACMA 2014: 1).

AUSTRALIAN JOURNAL OF TELECOMMUNICATIONS AND THE DIGITAL ECONOMY VOLUME 2 NUMBER 4, DECEMBER 2014
ISSN 2203-1693. http://doi.org/10.7790/ajtde.v2n4.73

While being “online and mobile” at the same time has become a commonplace experience in developing and developed countries alike, much of the marketing of mobile devices is focused on their entertainment and social networking capabilities. The increasingly ubiquitous nature of mobile connectivity, however, has the potential to change the way we interact with, and participate in, a range of political and institutional processes. This includes how we communicate with each other, with authorities and with non-governmental organisations during times of disaster and extreme events. This special theme of the *Journal* seeks to explore the role and potential of affordable telecommunications in providing more inclusive, bottom-up mechanisms for planning for, and responding to, natural disasters and extreme climatic events. The contributing authors explore this theme through a range of different technological and social lenses that highlight the rapidly changing nature of disaster-related communication and information provision, induced by technological innovation.

Global environmental change, local communication strategies

Climate change is a societal challenge of global proportions, and for over two decades, governments have discussed the importance of a global agreement to reduce greenhouse gas emissions and address the negative consequences of climate change arising from existing greenhouse gas emissions into the atmosphere (IPCC 2014). Despite the need for global solutions to fight the causes of climate change, it is important to acknowledge that, by and large, the impacts of climate change on humans, crops, or livestock take place at local and regional scales – they are experienced by people in their respective natural and social environments. The majority of disaster events – whether they are climatic, geophysical or technological in nature – are confined to local or regional geographic areas or landscapes, and consequently, emergency management and climate change adaptation planning efforts are focused on local-level action. Bushfires in south-east Australia, for example, are localised events that, in extreme cases, can expand to cover entire forested regions, such as during the 2009 Black Saturday fires in Victoria, in which 173 people died and 414 were injured (Climate Commission 2011). Heatwaves can persist across significant parts of the continent, yet they usually cause their greatest impact in urban areas where concentrated assemblages of people, the built environment, and an urbanised ‘natural’ environment result in the urban heat island effect, with sometimes severe consequences to human lives (Kovats & Ebi 2006).

These localised characteristics of disasters call for rapid, effective responses that are specific to location and embedded in social and ecological context. Local communities are typically the first responders, supported by locally or regionally based emergency management and community support organisations, many of which rely on volunteers and are poorly resourced.

Developing localised networks and mechanisms for early warning, response and recovery from disasters is a critical aspect of increasing social resilience and the capacity of communities to adapt to climate change and other dimensions of global environmental change (Davoudi *et al.* 2012; Sherrieb *et al.* 2010).

During and after disasters, communication technologies and networks become vital components of the response effort that can decide over life and death. However, all too often, communication infrastructure is itself affected by the disaster. Systems less prone to failure are required that are effective, easy to operate and use, and readily accessible. In the medium and longer term, developing more affordable, accessible, participatory and distributed telecommunications systems can become an integral part of resilience building and systemic adaptation to climate change. The characteristics of localisation, infrastructure-lite, flexibility and peer-to-peer topology featuring DIY telecommunications perfectly apply to this context. Effective disaster management and climate adaptation design should include these principles, to support participatory planning and responsive approaches that can make a difference to human lives during crises, as well as assisting in developing an adaptive capability in the face of climate change.

The makers movement and DIY telecommunications

Internationally, telecommunications provision has been predominantly organised through public monopolies or regulated markets, although the formation of telecommunication cooperatives – particularly in rural areas – points to bottom-up organisation in some cases (Fischer 1992).

With the exception of amateur radio, early telecommunications technologies – regardless of the provisioning model – channelled information flows up and down hierarchies, rather than directly across networks. The co-development of interactive digital technologies, peer-to-peer networking and DIY tinkering has reoriented communication flows and fostered participatory cultures.

For some years now, the "makers movement" has gained world-wide popularity as an emerging techno-culture. The maker movement has been defined in different ways, such as a "growing culture of hands-on making, creating, designing, and innovating" (Peppler & Bender 2013), or a culture that includes practices "from crafting to high-tech electronics" (Anderson 2012: 20; Manzini 2013: 2). Others have emphasised the participatory component of the movement by referring to it as a "democratised technological practice" (Tannenbaum *et al.* 2013: 2604).

Yet, the makers movement is not a new phenomenon, for it is connected to Do-It-Yourself (DIY) cultures of the previous decades (Hertz 2011; Doherty 2012; Powell 2012). Fox has

ISSN 2203-1693. Copyright © 2014 The Author(s). http://doi.org/10.7790/ajtde.v2n4.73

recently referred to a “Third Wave DIY” that “draws upon the read/write functionality of the Internet, and digitally-driven design/manufacture, to enable ordinary people to invent, design, make, and/or sell goods” (Fox 2014:19). The Web 2.0 ecosystem of social media, platforms, tools, etc. is currently enabling new forms of networked, real-time collective intelligence to solve issues when it comes to building any type of mechanical artefact, electronic device, software or hardware. To Dougherty, founder of the *Make* magazine in 2005, the Internet enables “today’s makers [to] enjoy a level of interconnectedness that has helped to build a movement out of what in the past would have been simply a series of microcommunities defined by a particular hobby or activity” (Dougherty 2012:2).

Another distinctive sign of the movement is “the combination of new economic funding models, physical spaces, new platforms, tools and publications” (Lindter *et al.* 2014: 440). More specifically, makers have leveraged crowdfunding platforms and social media to enlarge the community base of donors and developers, who may even overlap in some cases. Maker fairs, ‘fab labs’ and hacker spaces have blossomed in the USA and Europe, and are growing fast in Africa (Fox 2014: 20). In this new ecosystem, the boundaries between producers and users, hobbyists and professionals, are constantly redrawn. The paper by Antunes in this issue, discussing the design of affordable sensor networks where “the target user is not assumed to be skilled in communications” is a clear example of this intention to open up practices (i.e. environmental data collection) which were previously restricted to public agencies and/or professional researchers (Antunes 2014: 9).

Telecommunications has not remained unaffected by the DIY and makers’ movements (Poblet 2013). At present, the early ham radio communities coexist with wireless community networks across the globe. In festivals, campuses, or remote areas with either poor or unaffordable GSM coverage, DIY and open-source cell networks are introduced as either a proof of concept, a temporary solution, or as alternative telecommunications services (Ruiz 2013; Gallagher 2014; Patterson 2014). The exploration of these grassroots capacities extends to the production of DIY cell phones and routers (Mellis & Buechley 2014).

In parallel to these developments, the use of Unmanned Aerial Vehicles (UAVs), more popularly known as drones, has burst across the globe with the most varied applications. While Unmanned Aerial Systems (comprising UAVs, their control ground stations and communications systems) “constitute the most dynamic section of the aerospace industry” (Odido & Madara 2013: 108), communities of DIY UAVs are flourishing on the Web (the popular DIYDrones.com, started in 2007, has more than 60,000 members sharing experiences, instructions, and open source software). Equipped with cameras and other advanced sensors, civilian and personal drones enable observation, monitoring, mapping, and/or real-time broadcasting of environmental conditions, humanitarian crises, emergencies and other events. Likewise, DIY satellites, which have been used by amateur radio satellite communities for decades, are now becoming accessible to large communities. Open hardware, open standards, and inexpensive sensors are enabling projects that aim at a “democratisation” of the space for earth observation (Marshall 2014). PlanetLab, a start-up that has recently put into space a constellation of 28 earth-imaging satellites (10x10x30 cm.), or SatNogs, providing open source ground stations, are new entrepreneurial initiatives in this line. Yet, the democratisation of outer space will need to address multi-level regulations and, in some countries, contested “government export controls on satellite hardware and software” (Reyes 2014).

Despite the variety in scope, objectives and resources, these new generation DIY telecommunications initiatives and projects tend to share some distinctive features. In a nutshell, DIY telecommunications usually are:

- Local: DIY telecommunications emerge to satisfy a necessity inefficiently covered at the local level (poor infrastructure, lack of coverage, unaffordable costs, etc.)
- Ad-hoc: DIY telecommunications serve, at least initially, a particular purpose (e.g. access to a cell network, access to the Internet, provide an alternative to existing services, etc.)
- Infrastructure-lite: DIY telecommunications tend to keep infrastructure costs to a minimum so that the user base can expand.
- Flexible: DIY initiatives and projects are in perpetual beta trials and tend to evolve and adapt to different configurations depending on the contextual needs of the users.
- Peer-to-peer: DIY telecommunications have a preference for different decentralised topologies based on nodes and links rather than hierarchical structures.

Some of these features – notably minimal infrastructure, flexibility, and decentralisation – are typical of mesh networks as designed in the domain of information systems. In a similar vein, they also echo the SLOC model (small, local, open, connected) developed by Manzini as “a design guideline for creating resilient systems and sustainable qualities” (Manzini 2013). In our review of affordable telecommunications for disaster management and climate change adaptation, local strategies leveraging local capacities and shared, distributed knowledge across the Internet have a place in addressing these global challenges. The papers in this issue are also walking along this path.

Participatory approaches and institutional settings

While DIY telecommunications activists have frequently positioned themselves in opposition to markets and the State, the complex and evolving relationship between the sectors influences the capacity for bottom-up mechanisms to organise around disaster management.

Limitations have been placed on community activism through the State regulation of spectrum and telecommunications services, and aggressive litigation by commercial telcos seeking to protect their investment and market share. Community provision, sometimes supported by local governments, has in the past been viewed as a threat to competitive markets, seen as the preferred model for global mobile telecommunications. Other objections to community activism turn on claims of exclusiveness and unreliability.

The merits of these claims have been significantly challenged by civic and activist responses to disasters, including Hurricane Katrina (New Orleans 2006) and Hurricane Sandy (New York 2011). In both instances, public or community-run Wi-Fi networks proved the most robust form of telecommunications, providing vital information links for residents, first responders and city workers alike. In New Orleans' case, while commercial mobile services were knocked out, telcos and rival ISPs were sufficiently influential to have the free city Wi-Fi network throttled to a miserly 512Kbps in the immediate post-hurricane period. When the emergency period ended, network speed was further reduced to 128Kbps, to comply with Louisiana's broadband laws (Bangeman 2006). In New York, a Wi-Fi network launched by a not-for-profit in 2011 at New York City Housing Authority's largest public housing development, Brooklyn's Red Hook Houses, stayed on-line during Sandy and its aftermath, providing a lifeline for residents stranded in the complex without power or water (Kazansky 2012).

The aggressive stance of higher governments and telcos towards community and municipal activism, observed most in North America and Europe, has begun to soften, though. Smartphone penetration has driven demand for data beyond the capacity of some 3G and 4G networks, leading to commercial subsidy of public wireless networks to offload data traffic. An increasing array of cross-sector partnerships utilises the communication, data and geo-locative capabilities of mobiles in predictive, emergency and recovery situations. Major humanitarian agencies, such as the American Red Cross, have built capacities to gather and disseminate information through social media into core operating structures. However, this institutionalisation of digital humanitarianism has in turn led to new concerns over data privacy and security, and the targeting of communications infrastructure by State and non-State actors in parts of Africa, Asia and the Middle East.

These developments are framed by a rights-based stance on information access, articulated with renewed vigour by humanitarian and disaster relief agencies. As the UN Office for the Coordination of Humanitarian Affairs (2013:13) reminds us, the freedom to seek, receive and impart information in any media features in Article 19 of the 1949 UN Declaration of Human Rights. While acknowledging this universalism, the articles in this special edition show, also challenge us to understand mobile communications within their particular communication ecologies, and political and cultural settings.

The papers on this special theme

The articles on this special theme aim at exploring the role of affordable telecommunications in designing participatory approaches to disaster management and climate change adaptation. The projects, initiatives and technologies discussed target different issues and geographic areas, but they are all based on approaches that combine the use of inexpensive devices (e.g. mobile phones. two-way radios, or sensors) with local infrastructure capacities to produce contextualised, granular, and real-time information on climate and weather conditions, alerts, and disaster response. The "bring-your-own-device" approach adopted in most of these papers seeks to lower the learning curve for the participation of individuals and groups while diminishing the infrastructure requirements for an effective communication. In each case, nevertheless, a number of market constraints and regulatory issues are to be considered, such as compliance with spectrum licensing and usage policies at the national and international level.

The first paper by Alex Antunes ("Cheap deployable networked sensors for environmental use") proposes the deployment of inexpensive networked sensors for environmental monitoring. He argues that different affordable technologies are already in place to enable steady state data collection at the local, private and amateur levels. Antunes presents a model for inexpensive sensors, known in some maker communities as Dirt Cheap Dumb Wireless (DCDW) to enable new segments of non-professional users to monitor environmental conditions. The main limiting factors, according to Antunes, are not technical but regulatory. Thus regulations may impose either absolute or relative restrictions to different types of communications (e.g. FCC regulations on Low Power Radio Station (LPRS) that allow transmission of data but not for sensor purposes).

The next three papers on this special theme, while relying on different approaches, consider the present ubiquity of mobile phones across the globe to be a fundamental component of participatory disaster management.

In their paper ("Acoustic coupled disaster and remote communications systems") Müller-Baumgart *et al.* explore how to provide cost-effective communications in disaster-affected

ISSN 2203-1693. Copyright © 2014 The Author(s). http://doi.org/10.7790/ajtde.v2n4.73

areas where infrastructure has been severely damaged. With the aim of leveraging existing locally available hardware, the paper describes a possible solution based on acoustic coupling of mobile telephones with the two-way radios that are often carried in remote areas of Australia. The combination of these two devices has yet to address two types of challenges:

i) technical (e.g. how to interface digital communications systems to analogue devices, how to maximise the limited bandwidth available for data transmission) and

ii) regulatory (namely, how to make digital communications compatible with licences for citizen band radio that, in principle, do not cover digital transmission).

While further exploration needs to be done in both areas, the acoustic coupling would allow the broadcasting of weather information, local news and limited private messaging in disaster zones or remote areas where there is currently no such possibility.

The next paper, by Noske-Turner *et al.* ("Locating disaster communication in changing communicative ecologies across the Pacific"), provides a comparative overview of disaster communication systems and infrastructures, practices and challenges in the Pacific Island region, a very diverse geographical and cultural area. The authors argue that access to, and affordability of technologies, are just two of the variables to consider in disaster communication. Consequently, to achieve an effective communication strategy other qualitative aspects come into play, such as appropriate technologies, systems for the ownership and maintenance of infrastructures, or local knowledge and belief systems. The paper adopts the approach of "communicative ecologies", which prioritises local knowledge, to identify nuances in access, use, and practices. In this perspective both offline (traditional and face-to-face) and online modes become relevant when designing appropriate disaster communication strategies. The authors conclude that the accurate assessment of the "communicative ecology" of each particular area is vital for providing a better integration of mobile phones and other ICTs into disaster plans and policies across the Pacific.

The fourth paper is "Updating warning systems for climate hazards: can navigation satellites help?" by Handmer, Choy and Kohtake. The paper discusses the current disjunction between mainstream models of warning systems, the expectations of the public for personalised warnings, and the potential of social media and mobile technologies to improve both reach and effectiveness. It then makes the case for the integration of satellite navigation by proposing the use of the next generation of Japanese positioning satellites (QZSS, or Quasi-Zenith Satellite System). Satellite warning systems would be able to simultaneously deliver millions of individual warnings to personal devices while providing a backup system when local communications infrastructure fails.

The last paper on this special theme ("Warrnambool Exchange Fire: Resilience and Emergency Management") by Gregory *et al.* covers a very significant event in Victoria: a fire occurred on November 22, 2012 in the vicinity of Telstra's Exchange building in Warrnambool, Victoria, which severely impacted regional telecommunication services for more than two weeks. The paper does not strictly deal with the topic of participatory approaches as its aim is to provide lessons learnt from the incident in order to enhance increased resilience. However, the paper has the great value of illustrating the disruptive effects of a single point of failure disaster on telecommunications for individuals (especially the most vulnerable), communities, business, and local providers. As the authors put it, the "no one-size-fits-all solution" principle, (or location-based approach) needs to guide increased resilience strategies in the future.

We expect that this special theme will provide new insights on how global societal challenges such as climate change, disasters, and emergencies can be addressed with a new generation of telecommunications and technologies that leverage local capacities to provide ad-hoc, infrastructure-lite, flexible, and decentralised services and, ultimately, to enhance participatory approaches to tackle these major challenges.

Acknowledgements

We thank the authors of the papers for contributing to this special theme with their dedicated work. We are also grateful for the contributions of several people who have greatly helped us in its completion: Dr Peter Gerrand, Managing Editor of the *Journal*, for inviting us to edit this special theme and for his ongoing support; and Dr Andrew Glover, for his efficient assistance in coordinating tasks and communications. We are also thankful to all the referees who provided very valuable and timely reviews.

This special theme has also benefited from the support of the RMIT Friendship Research Grant offered by the School of Global, Urban and Social Studies (GUSS) and the Graduate School of Business and Law (GSBL). It has also partially benefited from research within the framework of two previous research projects funded by the Spanish Ministry of Economy and Competitiveness: CrowdCrisisControl (IPT-2012-0968-390000) and "Crowdsourcing: instrumentos semánticos para el desarrollo de la participación y la mediación online" (DER 2012- 39492 -C02 -01).

ISSN 2203-1693. Copyright © 2014 The Author(s). http://doi.org/10.7790/ajtde.v2n4.73

References

Antunes, A. 2014. 'Cheap deployable networked sensors for environmental use'. *Australian Journal of Telecommunications and the Digital Economy*, Vol. 2(4)

ACMA. 2014. 'Six emerging trends in media and communications'. Research report, available at: http://www.acma.gov.au/theACMA/Library/researchacma/Research-reports/six-emerging-trends-in-media-and-communications, retrieved November 24, 2014.

Anderson, C. 2012. *Makers: The New Industrial Revolution*. London: Random House.

Apvrille, L; Tanzi, T; Dugelay, J. L. 2014. 'Autonomous drones for assisting rescue services within the context of natural disasters'. In General Assembly and Scientific Symposium (URSI GASS), 2014 XXXIth URSI, 1-4.

Bangeman, E. 2006. 'New Orleans to take city-wide WiFi network offline', *Ars Technica*, October 24, available at: http://arstechnica.com/gadgets/2006/10/8052/, retrieved November 24, 2014.

CISCO. 2013. Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2013–2018, available at:http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html, retrieved November 24, 2014.

Climate Commission. 2011. *The critical decade: Victorian climate impacts and opportunities*, Canberra, available at: http://climatecommission.gov.au/wp-content/uploads/120719_VIC-report-web-version_final.pdf.

Davoudi, S; Shaw, K; Haider, L J; Quinlan, A E; Peterson, G D; Wilkinson, C; Fünfgeld, H; McEvoy, D; Porter, L. 2012. 'Resilience: A Bridging Concept or a Dead End?; "Reframing" Resilience: Challenges for Planning Theory and Practice; Interacting Traps: Resilience Assessment of a Pasture Management System in Northern Afghanistan; Urban Resilience: What Does it Mean in Planning Practice . *Planning Theory & Practice*, 13(2), pp.299–333, http://dx.doi.org/10.1080/14649357.2012.677124.

Dougherty, D. 2012. 'The maker movement'. *Innovations*, 7(3), 11-14.

Fischer, C. 1992. *America Calling: A Social History of the Telephone*, Berkeley & London: University of California Press.

Fox, S. 2014. 'Third Wave Do-It-Yourself (DIY): Potential for prosumption, innovation, and entrepreneurship by local populations in regions without industrial manufacturing infrastructure'. *Technology in Society*, 39, 18-30.

Gallagher, S. 2014. 'Cellular's open source future is latched to tallest tree in the village. *Ars Technica*', available at: http://arstechnica.com/information-technology/2014/02/cellulars-open-source-future-is-latched-to-tallest-tree-in-the-village/, retrieved November 24, 2014.

IPCC. 2014. *Climate change 2014: Synthesis report - Approved summary for policymakers, Geneva,* available at: http://www.ipcc.ch/report/ar5/syr/, retrieved November 24, 2014.

Hertz, G. 2011. 'Arduino Microcontrollers and the Queen's Hamlet: Utilitarian and Hedonized DIY Practices in Contemporary Electronic Culture' (ACADIA 2011).

ITU. 2014. *Facts and Figures*, available at: http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2014-e.pdf, retrieved November 24, 201.

Kazansky, B. 2012. 'In Red Hook, mesh network connects Sandy survivors still without power', 12 November, available at: http://techpresident.com/news/23127/red-hook-mesh-network-connects-sandy-survivors-still-without-power, retrieved November 24, 2014.

Kovats, R.S; Ebi, K.L. 2006. 'Heatwaves and public health in Europe', *European Journal Of Public Health*, 16(6), 592–599, available at: http://www.ncbi.nlm.nih.gov/pubmed/16644927, retrieved November 24, 2014.

Lindtner, S; Hertz, G. D; Dourish, P. 2014. 'Emerging sites of HCI innovation: hackerspaces, hardware startups & incubators'. In Proceedings of the 32nd annual ACM conference on Human Factors in Computing Systems, 439-448.

Manzini, E. 2013. "Resilient systems and sustainable qualities". Current: Design Research Journal, 4, 11-14.

Marshall, W. 2014. 'Tiny satellites show us the Earth as it changes in near-real-time', available at: http://www.ted.com/talks/will_marshall_teeny_tiny_satellites_that_photograph_the_entire_planet_every_day, retrieved November 24, 2014.

Mellis, D. A; Buechley, L. 2014. 'Do-it-yourself cellphones: an investigation into the possibilities and limits of high-tech diy'. In Proceedings of the 32nd annual ACM conference on Human factors in computing systems, 1723-1732.

Odido, M. D; Madara, D. 2013. 'Emerging Technologies: Use of Unmanned Aerial Systems in the Realisation of Vision 2030 Goals in the Counties'. *International Journal of Applied Science and Technology*, Vol. 3(8): 107-127, available at: http://ijastnet.com/journals/Vol_3_No_8_December_2013/15.pdf, retrieved November 24, 2014.

Patterson, S.M. 2014. ‘Open source project builds mobile networks without big carriers’, available at: http://www.networkworld.com/article/2226543/wireless/open-source-project-builds-mobile-networks-without-big-carriers.html, retrieved November 24, 2014.

Peppler, K; Bender, S. 2013. ‘Maker movement spreads innovation one project at a time’ Phi Delta Kappan, 95(3), 22-27, available at: http://pdk.sagepub.com/content/95/3/22.full.pdf+html, retrieved November 24, 2014.

Poblet, M. 2013. Affordable telecommunications: A new digital economy is calling. *Australian Journal of Telecommunications and the Digital Economy*, Vol.1(1), 12, available at: http://doi.org/10.7790/ajtde.v1n1.12

Powell, A. 2012. Democratizing production through open source knowledge: from open software to open hardware. Media, Culture, and Society, 34 (6): 691-708. http://dx.doi.org/10.1177/0163443712449497

Reyes, M.F. 2014. DIY Satellites: Now and near future. *Makezine*, available at: http://makezine.com/2014/04/07/diy-satellites-now-and-near-future/, retrieved November 24, 2014.

Ruiz, V. 2013. ‘Forgotten by telecoms, Mexico town runs cell service’. Phys.org [Internet]. Accessed 25 September 2013. available at: http://phys.org/news/2013-08-forgotten-telecoms-mexico-town-cell.html, retrieved November 24, 2014.

Sherrieb, K; Norris, F.H; Galea, S., 2010. “Measuring Capacities for Community Resilience”. *Social Indicators Research*, 99(2), 227–247 LA – English. available at: http://dx.doi.org/10.1007/s11205-010-9576-9.

Tanenbaum, J. G; Williams, A. M; Desjardins, A; Tanenbaum, K. 2013. ‘Democratizing technology: pleasure, utility and expressiveness in DIY and maker practice’. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2603-2612.

UN Office for the Coordination of Humanitarian Affairs. 2013. ‘Humanitarianism in the Network Age’, available at: https://docs.unocha.org/sites/dms/Documents/WEB%20Humanitarianism%20in%20the%20Network%20Age%20vF%20single.pdf , retrieved November 24, 2014.