

# Using Technology Tools to Enhance the Resilience of Marginalized Communities

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## Abstract

*Poor access to public services in marginalized communities increases their vulnerability; technology can contribute to making these services more accessible. Reducing the digital divide can help communities to be prepared for unexpected risks. The thesis statement presented is that information, linked with citizen participation through community commitment and technology, can enhance the resilience of marginalized communities. The tools proposed to achieve this are community mapping, citizen complaint tools and Retail Location Analysis. To answer the question How can proper data use improve people's life, we study the case of a community that lacks adequate preparation against possible crisis —the community of Tizilingo, in Xochimilco (Mexico City) —, in comparison with two cases of communities that have been successful in doing so —in Haiti and Kenya.*

## KEY WORDS:

Technology, poverty, vulnerability, participation

## 1. Introduction

72 million people in extreme poverty conditions live in Latin America and the Caribbean (Roldán, 2015), they do not only face great economic struggles but are also surrounded by a number of challenges that have turned their everyday living conditions into a continuous threat. Underserved human settlements across the world in both urban and rural contexts are currently struggling to understand and overcome the social and environmental factors behind their exclusion and vulnerability conditions.

There are many questions about which would be the best strategies to face this battle; however, we can be certain that the most successful ideas will be those that go beyond

individual efforts to become real collective actions. Communities as a whole should be part of the solution to their problems and not only spectators. The first challenge is therefore to generate interest among communities to solve the problems that surround them, but to awaken a motivation for participation in contexts where the social fabric is weak is already a huge challenge.

We believe that the first step is to generate information. It is impossible to expect behavior changes without a correct understanding of the problem; however, it should be noted that the inhabitants of these settlements live the daily consequences of their hard environment—e.g. it is them who have to endure water shortage or soil erosion, it is also them who live with the constant fear of being evicted or ending as victims of violence— so creating awareness of these issues would not be of particular impact. Our vision is that what is really needed is to provide information about what is causing these problems, but most importantly to share experiences on what others are doing to solve them.

It is crucial for people in hardship to know that they are not isolated and that there are experiences that prove that it is possible to adapt and overcome the problems they are facing. Communities must also be able to generate and organize their own information in order to properly understand the size of the challenges they face.

The purpose of the present document is to show how community involvement and the use of technology can enhance resilience among underserved human settlements. It is of our understandings that if a community has not only information but also the tools to effectively use it and share it, resilience can be strengthened by providing opportunities to face and solve problems in a better and more adequate fashion. We present various projects that fight the lack of resilience with strategies of community involvement, showing that technology opens the possibility of easily organizing, visualizing and generating useful data that will allow vulnerable communities not only to adapt but also to take action towards the threats they are trying to fight.

## **2. Elements of Vulnerability**

As with the concept of resilience, there is still no universal theory or model of vulnerability within literature, even less a broadly accepted single definition (Hufschmidt, 2011, p. 623) (Cutter, et al., 2008, p. 588). But rather, multiple definitions exist according to different lines of research that have evolved over time, including the type of hazard they focus on, and whether it refers to a single stress (like a single natural hazard or a terrorist attack) or to multiple stresses (like climate and environmental change). Consequently, there is no

standardized procedure for measuring vulnerability, neither qualitatively or quantitatively (Hufschmidt, 2011, p. 636).

Usually, studies on urban vulnerability tend to portray it in negative terms, as the possibility to be harmed, the potential for loss, the function of exposure and sensitivity or as the degree to which a system is susceptible to and is unable to cope with the adverse effects of a single or several hazards or stresses (Romero-Lankao & Quin, 2011, p. 143) (Cutter, et al., 2003, p. 559).

It is important to highlight that vulnerability is a decisive variable in increasing the risk of a hazard becoming a disaster. As adaptation to hazards of whatever kind is seen as key for reducing this risk, adaptive capacity or the lack thereof was also introduced as a central element for explaining vulnerability. The diversity of concepts makes it clear that vulnerability has a multidimensional nature. Nevertheless, it is commonly accepted that the most vulnerable are those whose lives are the most constrained, such as people living in poverty, who have the least access to coping resources (Godschalk, 2003, p. 140).

Thus, the socio economic dimension plays an important role, but it is not the only one. Some authors distinguish between vulnerability as an outcome (physical vulnerability) and inherent urban vulnerability (Romero-Lankao & Quin, 2011, pp. 143-144), while others define it as a complex interaction between its biophysical and social components, whereas social vulnerability is a multidimensional concept in itself (Cutter, et al., 2003, pp. 257-258). Hence they differentiate between the environment, such as waterways and soils, among others, and the built environment, in particular critical infrastructure, including transportation, information and telecommunications systems, health system, the electric power grid, emergency response units and food and water supplies on the one hand; and social, economic, political and cultural aspects on the other hand. The latter include the socioeconomic status as income, access to political power and representation, access to resources -including information, knowledge and *technology*-, as well as social capital, including social networks and connections. Beliefs and customs may also be an important element, as well as gender, race/ethnicity and age (children and elderly being the most vulnerable ones). The commercial and industrial development of the community can also be decisive, as is whether it is situated in rural or urban settlements, its dependency on a single economic sector and its unemployment rate. Other aspects that may have an impact when a hazard occurs are education and language skills, family structures, medical services and population growth, but also the built environment's density and the (in)formality of the housing (Cutter, et al., 2003, pp. 246-249) (Jabareen, 2013, p. 222).

Major factors that increase vulnerability include a disaster-prone location of the community, insecure sources of livelihood, risky sources of livelihood, lack of access and control over means of production (land, farm inputs, animals, capital etc), dependence on money-lenders etc., inadequate economic fallback mechanisms, occurrence of acute or chronic food shortage, lack of adequate skills and educational background, lack of basic services (education, health, safe drinking water, shelter, sanitation, roads, electricity, communication, etc.), high mortality rate, malnutrition, occurrence of diseases, insufficient care capacity, over-exploited natural resources and the exposure to violence (domestic, communal or war related). Organizational factors that increase vulnerability are usually weak family or kinship structures, lack of leadership or initiative, lack of an organizational structure to tackle problems, ineffective decision-making, exclusion of people or groups, uneven participation in community affairs, gossip, internal divisions, conflicts (ethnic, class, caste, religion, gender, ideology, etc.), injustice, impunity, lack of access to political processes, lack of or absence of community organization (formal, informal, government, indigenous), neglected relationship with the government or administrative structures, as well as isolation.

Furthermore, the negative effects of climate change and global warming that may increase or decrease the extreme temperatures and precipitation depending on the region conditions are pushing new forms of vulnerability (UNISDR, 2012, p. 8).

Last but not least, motivation and positive attitudes have an important influence on vulnerability, whereas negative attitudes towards change, passivity, fatalism, hopelessness, lack of initiative, no fighting spirit; lack of unity, cooperation and solidarity; lack of awareness about hazards and their consequences, and dependence on external support increase vulnerability (Cannon, et al., 2004).

As noted by various authors mentioned above, vulnerabilities are partially a product of social inequalities, and therefore an equity and human rights issue (Cutter, et al., 2003, p. 243) (Cutter, et al., 2008, p. 598).

### **3. Elements of resilience**

While some authors conceptualize vulnerability as the flipside or complement of resilience -or even as a loose antonym- the concepts express quite different yet reciprocal conditions, which combined display a high potential for explaining risk (Hufschmidt, 2011, p. 629) (Adger, 2002, p. 348). Both concepts draw on the diversification of adaptation capacities as a central element for reducing vulnerability and enhancing resilience

(Hufschmidt, 2011, p. 632). Nevertheless, the focus diverges: while vulnerability expresses the potential degree of being wounded, resilience addresses the potential degree of rapidly absorbing adverse effects inflicted by this wound and remain functioning (Hufschmidt, 2011, p. 636). Both are overlapping concepts, neither mutually exclusive nor totally inclusive: some characteristics influence vulnerability only or resilience only, while social characteristics have an influence on both, like socioeconomic status and education (Romero-Lankao & Quin, 2011, p. 145) (Cutter, et al., 2008, p. 602). They also have in common being dynamic processes (Cutter, et al., 2008, p. 599). Depending on the focus of resilience (of what and to what), there are a variety of definitions (Hufschmidt, 2011, p. 626) (Godschalk, 2003, pp. 137-138) (Cutter, et al., 2008, p. 599) (Jabareen, 2013, pp. 220-221) (Adger, 2002, pp. 347-349): some identify self-organization and recovery as central elements alongside adaptive capacity (Hufschmidt, 2011, p. 626); others distinguish between two qualities: inherent resilience —i.e. functioning during non-crisis periods—, and adaptive resilience, —i.e. flexibility during disasters (Cutter, et al., 2008, p. 611). Resilience can also be divided in three different phases: preparedness or preparation, coping or immediate response activities during crisis, and recovery activities. Sustainability seems also to be an important factor for increasing resilience (Godschalk, 2003, p. 137) (Ahern, 2011, p. 3), since there is a clear link between social and ecological resilience (Adger, 2002, p. 347).

Therefore a resilient city may be defined by the overall abilities of its governance, physical, economic and social systems and entities exposed to hazard, to learn, be prepared in advance, plan uncertainties, resist, absorb, accommodate and recover from the effects of a hazard in a timely and effective manner, including throughout the preservation and restoration of its essential basic structures and functions (Adger, 2002, p. 227).

In order to achieve resilience combinations of apparent opposites are required: redundancy and efficiency, (biological and social) diversity and interdependence, strength and flexibility, autonomy and collaboration, planning and adaptability, and multiscale networks and connectivity (Godschalk, 2003, p. 139) (Ahern, 2011, p. 4). In turn, these combinations require collective learning, self-organization and participation of people and local stakeholders, including the private sector, various social groups, communities, civil society and grassroots organizations (Jabareen, 2013, p. 223).

In 2015 the UNISDR updated the Ten Essentials for Making Cities Resilient. The New Ten Essentials focus on strengthening cities' financial, institutional, and societal capacities for resilience and are already being loosely applied by cities like Istanbul Metropolitan

Municipality (Turkey) and the City of Karlstad (Sweden). Integrating disaster risk reduction (DRR) into urban planning is difficult for many urban areas either due to a lack of knowledge, resources, capacity, or coherence between national and local strategies (ICLEI, 2015, p. 8).

These ten essentials are:

- Organize for disaster resilience
- Identify, understand and use current and future risk scenarios
- Strengthen financial capacity for resilience
- Pursue resilient urban development and design
- Safeguard natural buffers to enhance the protective functions offered by natural ecosystems
- Strengthen institutional capacity for resilience
- Understand and strengthen societal capacity for resilience
- Increase infrastructure resilience
- Ensure effective disaster response
- Expedite recovery and build back better (UNISDR, 2012, p. 5)

Since inequalities such as poverty, marginalization, lack of access to information and public participation in decision-making, among others, increase vulnerability so drastically, resilience becomes a matter of distribution equity and justice, requiring a participatory approach.

#### **4. Underserved Human Settlement in Mexico:**

According to the National Institute of Statistics and Geography (INEGI), in 1950 only 43percent of Mexico's population lived in urban areas. By 1990, urban population accounted for 71 percent, rising almost to 78 percent in 2010.

This demographic phenomenon, initiated by the intensive migration from the countryside to the city and by the drastic reduction in infant mortality in the mid-twentieth century affected each city in different ways.

In terms of housing, continuous modification of the urban development programs, insufficient assessments of the impact of urbanization, and the shortage of affordable housing for the poorest sectors, among others problems, led to an uncontrolled urban growth. This affected the supply of goods and services ranging from basic infrastructure

such as water, drainage, light and security, to publicly efficient urban mobility and insufficient development of green areas, thereby impairing the quality of life of the whole urban population. This phenomenon occurs with greater intensity in underserved human settlements. (Observatorio del Derecho a la Vivienda, 2015).

An example of this is the community Tizilingo, a community of 35 families that is in a natural reserve area in the upper part of Xochimilco, a municipality located in Mexico City.

The families that have moved to Tizilingo mention that they have moved there for economic reasons. The community is vulnerable to many hazards due to its high densification and the lack of proper access to the community, the settlement is not planned, it lacks public services, drinking water, sanitation services and electricity.

Housing conditions are precarious particularly due to the lack of water, which has to be carried in three times a week from a neighboring community. Moreover, there is no garbage collection system, so families regularly burn their garbage every week. This practice caused a fire in the community in 2013. A family was burning garbage and the fire got out of control. The firemen could not reach the community for the lack of access facilities and paved roads. Since firemen could not reach the fire, the community handled the situation before it reached the wooden houses they live in and luckily it was controlled. However, this situation showed the level of risk that the lack of services and proper access provokes.

This is an example of how the lack of basic services such as garbage collection system, access to water, paved roads and difficult access to the community exposed the community to a potential disaster. It is important to note that this situation could have been prevented if the community had the capacities, tools, services and technology to reduce this type of risk.

Since then, the organized community has carried out important efforts to make itself more accessible, but these efforts are insufficient to make the community resilient.

## **5. Data for resilience**

Before the technological age information was a privilege accessible only for a few, however, the current paradigm has changed this and the dissemination of technological tools opens a new and very important opportunity for data to be generated and shared within the most vulnerable contexts. This is why to strengthen the resilience of the most underserved communities requires breaking the traditional paradigm and focus on the



development of strategies aimed at putting the poorest people in the center of the creation of relevant information to prevent and cope with problems they face.

To develop effective policies towards making communities more resilient the first step is identifying potential hazards, vulnerabilities and lack of services. In order to do this, a solid foundation on data is required. Even though many countries are carrying out efforts to increase the amount of information collected, data at the local level remains limited and generally inaccessible, and in countries like Mexico the lack of coordination between stakeholders often causes duplicate efforts.

Solving this problem requires not only to make data publicly available, but also an attempt to standardize databases so that indicators obtained in different regions can be directly comparable. This will allow the reuse of data in different projects and open up the possibility of using new analytical tools to integrate and visualize complex information from multiple sources to support the development of integrated solutions (Observatorio del Derecho a la Vivienda, 2015).

Several projects have started to involve community members in data generation and project implementation; on the one hand this “helps to understand the audience’s diverse needs, priorities, motivators, and barriers to action” (ICLEI, 2015), and on the other hand, it can leverage the capabilities of the society as a whole to develop projects that would otherwise be impossible or too expensive to carry out. Another element that should be taken into account is the fast expansion of smart cell phones and broadband networks, elements that have allowed to reach unprecedented levels of connectivity, creating simpler and better ways for the community to be involved in policy creation. Examples of such projects are hazard mapping, crowdsourcing and citizen complaint apps.

Technology should not be seen as a luxury but as an important tool that can be used in favor of the people to improve their living conditions. Technology can also empower historically isolated individuals and groups and serve as a tool to enhance educational opportunities (Goslee, 1998: Sanyal & Schon, 1999 cited in Servon, L. & Nelson, M., 2001). Although it has been proved that technology can foster resilience in vulnerable communities, it is still not possible to provide technological solutions in every context, causing a digital divide. According with *Falling through the Net: Toward Digital Inclusion*, published by the National Telecommunications and Information Administration (NTIA 2000), the divide between those with access to telephones, computers and the Internet still exists and in many cases, is actually widening over time.



The digital divide is defined as the gap between the ones with access and the ones with no access to ICTs. Different factors can cause this digital divide, the most common are the lack of economic resources, knowledge and abilities to use technology, lack of access to internet as well as electronic devices, but also geography, age, ethnicity, gender, among others (Cullen, 2001; Compaine, 2001; OECD, 2002; Warschauer, 2003; Mossberger, et.al., 2003; van Dijk, 2005; OSILAC, 2007; Hilbert, 2010). The limited or lack of access to technology makes bigger the digital divide, because it depends on many other factors besides providing technology for everyone.

According to The National Institute of Statistics and Geography (INEGI), in Mexico in 2014 the most common form of internet access was through home networks (56.8%). It is important to notice that only 12 million of the population had computers in their homes, and 16% did not have internet connection because of economic problems (considering a total population of 119.715.000 people) (INEGI, 2015).

The digital divide is not only a matter of access to technology, but a greater social problem that causes inequality. ICTs cannot be used if you do not pay for them; even though they are currently the most used and efficient tool to inform and to be informed of everything that happen around us.

The problem is not only the lack of technology but also the lack of knowledge. Internet and computers are nothing if we do not know how to use them or do not take advantage of their content..

All these elements —the lack of technology (computers, internet), the ignorance of its use and the ignorance of its content—, make the digital divide even bigger. (Servon, L & Nelson, M, 2001)

A solution proposed to bridge the digital divide that has had results in Mexico is the use of specialized community centers, where people of all ages can go to, learn how to use a computer and how to face the internet and all its implications. These centers must meet certain requirements in order to function properly, such as: (i) physical space: the space is important and should be a place where the community feels identified and safe; (ii) computers: the computers must be available for free; and (iii) facilitators: there must be trained people that can guide others in the use and understanding of the internet and its content. (*Red de Innovación y Aprendizaje (RIA)*<http://enova.mx/es/node/194>)

The use of technology is a right that provides the necessary tools to face certain events. The right use of technology can help entire communities to improve their lives and connect

with the rest of the world,( Servon, L & Nelson, M, 2001), but the answer is not only to provide technology, but to give the necessary tools in order to take advantage of it.

## **6. Community Mapping, Haiti and Kibera**

“Haiti remains the poorest country in the Americas and one of the poorest in the world (GDP per capita of US\$ 846 in 2014) with significant needs in basic services. According to the latest household survey (ECVMAS 2012), more than 6 million out of 10.4 million (59%) Haitians live under the national poverty line of US\$ 2.42 per day and over 2.5 million (24%) live under the national extreme poverty line of US\$1.23 per day. It is also one of the most unequal countries, with a Gini coefficient of 0.61 as of 2012.” (The World Bank, 2016). When talking about resilience in urban areas it is necessary to consider the case of Haiti. With a devastating earthquake in the very recent history of the country, resilience is a topic that has been debated in Haiti for over 4 years now.

“Because of its location in the Caribbean hurricane zone and widespread deforestation, Haiti has long faced severe natural and human-created hazards” (Singh & Cohen, 2014). In this sense, many projects in many different areas have been developed, most of them focused on the humanitarian response after the earthquake and nowadays oriented towards long term development.

One of these projects, dedicated to strengthen resilience in urban communities, was the Community Carradeux Revitalizing Project.

Carradeux is a community of displaced population, located in the commune of Tabarre in the surroundings of the City of Port au Prince. Carradeux was first established as a camp in May 2010, when 1,082 households were selected by the Haitian government to move from the grounds of St Louis Gonzague School where they had settled after the earthquake destroyed their homes.

Once this government-sanctioned move was completed, additional unsanctioned camps quickly established themselves along Carradeux’s borders.

Nowadays Carradeux hosts over 3000 families.

Some facts about the community:

- 51% of the population lives in tents and 49% lives in shelters.
- 98% of the population lacks access to WASH services.
- The community is a camp of displaced population affected by the earthquake.
- Before the implementation of the project, the community did not have any risk assessment.

“The most vulnerable populations are those who lack the resources and capacity to adapt. This includes people living in extreme poverty, especially women, who must spend considerable time and energy providing food, water, and firewood for their households. Dependent people, such as young children and elderly persons, are also at high risk. Food insecurity and the impacts of the 2010 earthquake further negatively affect people’s lives” (Singh & Cohen, 2014).

Carradeux lives in conditions that are challenging for its people’s lives. Natural and human hazards are threatening the community’s wellbeing. Therefore many projects have been developed in the area such as public bathrooms, shelters and disaster risk reduction management training.

But, how can these projects build on the long-term development of the community if the hazards are still there threatening the community?

That is why the Carradeux example is interesting, because it was thought to increase the resilience of the community: rather than just providing with basic services to cover basic needs, it was understood that the community needed to develop the skills to be resilient as a transversal component of any project that would be developed in the community.

The project of Carradeux was a Pilot program to test a viable housing policy to be implemented in Haiti, observing a multi-dimensional perspective considering housing development as a core but surrounded by essential elements of community participation, increased resilience and empowerment processes to make the project sustainable.

In this document we will focus on the participatory approach and how a risk mapping could increase the resilience of the community not only in terms of the mapping itself but in terms of the empowering process of making it.

The Risk Mapping made in Carradeux was a process that started with training in disaster risk reduction with an approach of community management developed by the Dutch organization Cordaid (Cordaid, 2016).

This approach privileges all the processes that involve the community and does not recommend any outside decision-making only outside input and involvement. This means that all the processes of risk assessment, and mapping are led by the community and supported by some Cordaid trained professionals.

During a process of 9 months, the Community developed a map where they identified the risks in the community. (Photo 1)

First the community made a Risk Map. This is a specific map of the community made by the members of it in which they identify the areas that can be affected by a hazard.



**Photo 1: Shows the community developing a risk map**

As part of the mapping of which areas could be at risk of flooding, the participants also defined a mapping of the existing capacities present in the community. This information is very relevant to define how to reduce the risk. (Photo 2)

During the workshops the participants defined the risks and capacities and identified how vulnerable each person is according to the risk of flooding.

The participants, after identifying all the risks, capacities and degree of vulnerability prepared a map in which they would graphically identify each aspect.



**Photo 2: Shows an exercise of risk mapping made during the workshops.**

The final mapping was made in a 3 day workshop with the participation of the 50 members of the community that had attended the previous preparation workshops.

The final result was the ultimate assessment and mapping of risks and capacities in Carradeux.



**Photo 3: Presentation of the risk assessment to the Community.**

The risk assessment made by the community was presented to its members during a whole day, inviting everyone to see the risks and identify their own capacities. (Photo 3)

During the day, the community leaders took feedback from the rest of the community members and modified the map according to this assessment.

The validated risk map was defined by all the members of the community, with a clear set of steps to continue improving it, in case the community changes and to be able to update it as time goes by.

The risk assessment leads to the following stage of the process: Urban Planning.

So, what happened with this map?

This was posted at the community center for everyone to look at it.

What could have been different?

Whilst the process was successful, the materials have not been used for other purposes because the information is only available at the community center, it has not been transferred to digital resources that would make it possible to share it and elaborate on it.

What if we could use the community as one of our main sources of information and elaborate on all the findings, based on a participatory process?

With the Carradeux example, we can see how resilience can be built through participatory processes especially regarding the identification of risks. However, various projects have shown how technology can improve and facilitate this kind of efforts. An example of this is

the project implemented in Kibera Kenya, where residents were trained to use hand-held global positioning system devices (GPS) to collect geographic information.

The Kibera project went even further by adding more detailed mapping of services such as health, roads, security, education and water sanitation, using open GIS software like QGIS to produce specialty maps to do further analysis and OpenStreetMap to generate interactive maps.

This project is an example of how the translation of information, using technology, can give the community and the involved stakeholders the data to take better decisions. (Map Kibera Trust, 2016).

These data also opens up the possibility of using geographical algorithms like location analysis tools to discover blackspots where there is no provision of basic services, identify hotspots of crime within big regions or analyze traffic patterns.

Improving the efficiency of public services is one of the most important tools available to governments to reduce public spending while improving living conditions. Some cities have already implemented research on the location selection for urban public service facilities based on GIS spatial analysis [ ] This analysis evaluates the potential opportunity for a specific site as it takes into consideration characteristics such as age, income and population. It also allows the analysis of the area boundaries based on drive time analysis and other influencing factors such as topography, competition, and regional accessibility.

In Mexico there is a great need for this type of projects mainly in irregular settlements surrounding big cities, since the lack of basic services and risk assessment place them in a situation of low resilience.

## **7. Conclusions**

Improving the resilience capacity of marginalized communities is key to reach better living conditions in the most vulnerable sectors of the population.

As seen in the examples provided in this paper, technology can increase the access to information that can allow the community and the relevant stakeholders to understand the risks and capacities present in the community; therefore this can also improve the way community members and authorities react to possible risks.

The use of technology tools in vulnerable communities is an opportunity not only for academic research, but also for its development and application through public policies to solve real problems.



Information and community participation contribute to the development of better prepared and more equal societies.

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