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Emergency Telecommunications for Managing Disasters: A Complexity Science Perspective

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Abstract

Telecommunications technologies have shown great potential for humanitarian relief on a global scale. The complexity of the disaster scenario makes necessary to develop new strategies in order to respond efficiently and in a timely manner to humanitarian needs when disasters occur. Given the rapid technological advances and their associated convergence, we argue that the elements (subsystems) of a telecommunications system cannot be seen in an isolated manner, neither be conceptualized only as infrastructure; an interdisciplinary perspective is required. We suggest that a fragmented approach to telecommunications systems limits their application and effectiveness in disaster relief and recovery. In our approach, we consider the emergency telecommunications ecosystem as a socio-technical system. The understanding of the interactions of the main agents of such ecosystem is key to respond to disasters in a coordinated and orchestrated manner. Telecommunications technologies are important enablers, but should not be considered the center of the planning and execution stages of the disaster management process.

Keywords: Emergency Telecommunications, Disaster Management, Complexity Science, Climate Change

Introduction

Emergency telecommunications play a key role in practically all stages of the disaster management process. In order to respond expeditiously to preparing, warning, supporting and rebuilding when disasters occur requires the participation, coordination and orchestration of a wide variety of stakeholders (individuals, communities and institutions). The effective use of telecommunications systems to support this process entails more than the

availability of infrastructure and connectivity. The understanding of the dynamics of the ecosystem at the local, regional and national levels is very significant to accomplishing the effective use of telecommunications technology. According to the International Telecommunications Union (ITU), we face a multi-hazard, multi-technology, multi-phased and multi-stakeholder disaster management scenario (ITU-T, 2013).

This article proposes that the telecommunication system is in itself an open system where the interaction and interdependence of technological, environmental, sociocultural and economic factors play a key role in the characterization of this system. We conceptualize emergency telecommunications as a dynamic and complex adaptive system. We posit that a complexity approach may lead to further findings towards the creation of a framework for disaster management involving the most significant stakeholders at the different levels of coordination. The ETC 2020 initiative by the Emergency Telecommunications Cluster (ETC, 2015; WFO, 2016) intends giving a rapid and effective response to disaster management and mitigation through the interplay of local, regional, national and international stakeholders, as well as, communications providers and equipment manufacturers. This initiative is relevant because it takes into account the interdisciplinary nature of the disaster management process and the characteristics of the particular contexts.

In the area of disaster communications, technology does not create value on its own. However, it is urgent to develop capacity building strategies in order to apply technology wisely to disaster prevention, education, execution, decision-making and relief. Furthermore, it is critical to develop a road map with guiding principles for Information and Communications Technologies (ICT) intervention when disasters occur.

We start our exploration identifying the main agents of the ecosystem: Government, local, regional, national -and in many cases- international authorities, academy, telecommunications providers, NGOs, and mainly, the affected population. We propose that associated to these agents, the elements shown in Figure 2 play a pivotal role in orchestrating an integral approach to use telecommunications technology in case of disasters. It is also important to acknowledge the importance of the information flows that have a direct impact in managing efficiently the required response at the three crucial stages of the technological intervention: before, during and after (See
Figure 3).

Figure 2. Main components of an orchestrated approach to respond to disasters.

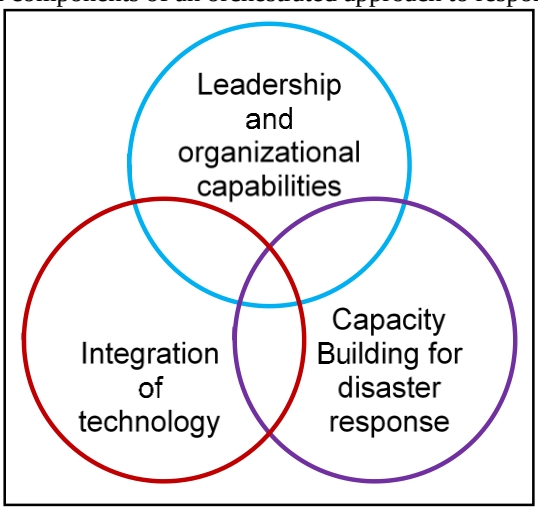
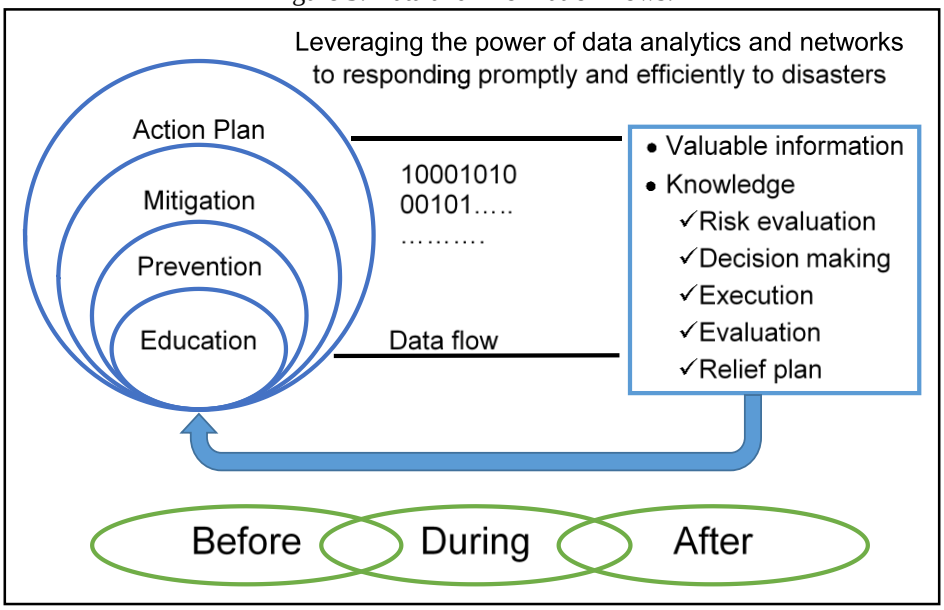


Figure 3: Data and information flows.



Exploring a Complexity perspective

Climate Change calls for urgent attention to initiatives and strategies centered in minimizing and preventing damages caused by natural disasters. A fragmented perspective in dealing with all the disciplines and different stakeholders involved imposes additional challenges that in many cases inhibit the deployment of a prompt and effective action plan. It has been shown that the availability of equipment is important to responding efficiently in all the stages, however, the main concern is to develop a

comprehensive framework to allowing the coordination and harmonization of efforts; hence, the consideration of both technology and human factors is essential from the inception of the planning and action stages (ITU-T, 2013).

In order to create an emergency response framework that provides all the agents of the ecosystem with a seamless, resilient and on time communication experience ("desired reality"), we start our methodology exploring the condition of the current ecosystem in a particular context ("observed reality"). Evolving from the observed to the desired reality requires unity of vision and purpose among all the agents involved in this ecosystem. It is crucial to identify the issues where the use of technology is critical to accomplish the goals of an orchestrated emergency telecommunications environment. Therefore, it is key to raise questions related to those strategies that support the transition from the observed to the desired reality (García, 2006). We use as an example the floods occurred in Villahermosa, Tabasco, Mexico during 2007 and 2009. (See Photo 1 and Photo 2) (UNDP, 2014).

The floods in Villahermosa, Tabasco caused enormous losses both human and material. Particularly in 2007, the damage was estimated of around 5 billion dollars, affecting over a million people.

Photo 1: Floods in Villahermosa, Tabasco.

Affected infrastructure in the city of Villahermosa Tabasco, Park-Museum de la Venta.

Source: Cristel Cruz, Villahermosa

Photo 2: Floods in Villahermosa, Tabasco.

Affected neighborhoods in Villahermosa, Tabasco.

Source: Cristel Cruz, Villahermosa

After defining the research questions, we proceed to analyze the three levels of operation and the interactions among the stakeholders of such levels as shown in (Castañares-Maddox, 2009). From this analysis, we identify the elements of orchestration and hypervision necessary to provide an integrated response to disasters highlighting the key role of technology in responding quickly and cohesively during the three stages of the process (see Figure 4). Based on these results, an action plan -reflecting the nature of the context, the stakeholders' interactions and the required technologies- is defined. This action plan will depend on the specific type of disaster and on the elements described in and

Figure 4: Observed Reality, Research Questions and Desired Reality.

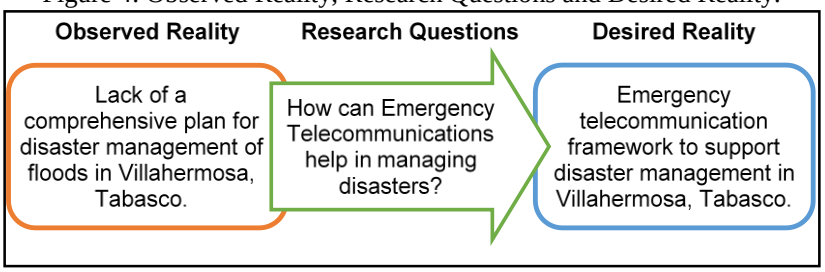
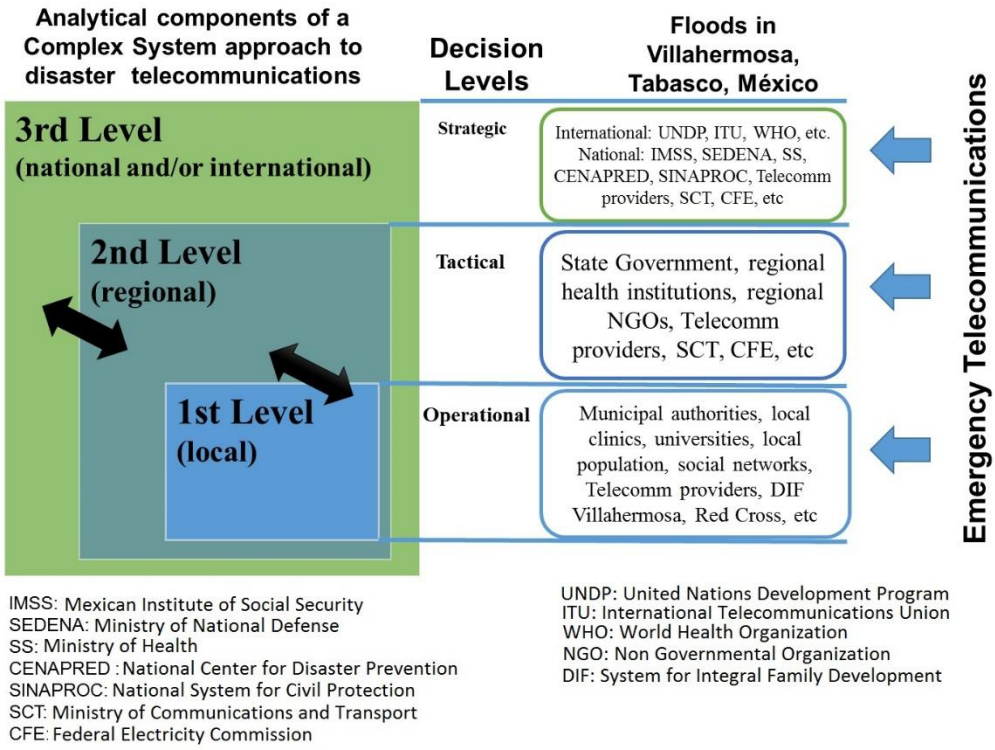


Figure 5: Complex System approach to disaster telecommunications.



The use of emergent telecommunications technologies has been crucial in recent events worldwide, but particularly in the case of the Tabasco 2007 and 2009 floods, the use of mobile phones for allowing immediate distribution and communications of alerts, interaction among all the stakeholders; and most importantly, among all the affected citizens and relatives in Tabasco and elsewhere, had a substantial effect in diminishing the negative impacts of the event. The availability of mobile phones in practically all the households and inhabitants of the capital city of Villahermosa played an important role in the mitigation efforts during and after the floods, as well as in the previous stages of prevention (Appleby, 2013; UN Global Pulse, 2014).

As described in

Figure 6, technology does not create value on its own; therefor, it is also fundamental to take into account the human behavior aspects involved in disasters, such as warning and crisis management. At the same time, it is important to develop public awareness strategies to face the challenges of disaster management in this conjuncture of global Climate Change.

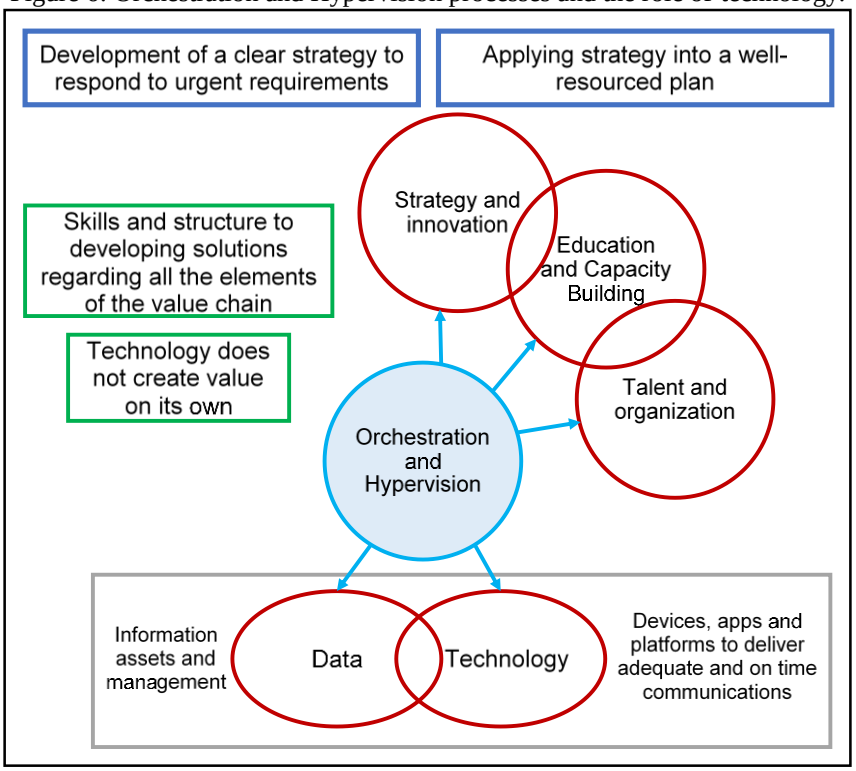
Our approach to disaster management from the perspective of complexity science does not intend to provide the best solution, but to think differently and pose the right questions conducive to accomplish an integrated response to urgent requirements of emergency telecommunications applications when disasters occur. There is not a universal strategy or prescription, however, it is critical to identify the role of technology in all the stages of the process in order to use it wisely and effectively.

The wise and adequate use of combined technologies with a clear and integrated vision of the complex nature of disaster management may provide support to municipal, regional and national authorities in charge of disaster attention and prevention. A clear strategy to respond to urgent requirements, as well as the implementation of such strategy into a well-resourced plan, become key elements as it is described in Figure 4. Capacity building in aspects covering the technical and human factors involved in disaster management is also of vital importance.

The effective use of telecommunications technologies for disaster management depends also on the adequate and timely flow of communication among all the stakeholders (See

Figure 6). Availability of trusted data and the use of data mining and satellite mapping information have been useful in combination with other visualization tools and emergent mobile telecommunications technologies.

Figure 6: Orchestration and Hypervision processes and the role of technology.



Conclusion

The fast pace of technology design and development provides an opportunity to deploy ICT in a coordinated and effective manner to support affected populations by disasters. Furthermore, ICT have the potential to empowering those affected populations, telecommunications providers and governments to coordinate their responses to disasters. We stress our proposal to consider the emergency telecommunications ecosystem as an open and adaptive complex system of local and international agents, humanitarian agencies, healthcare specialists, private sector organizations, and governments, to mention the most important. Given the challenges of a fast-changing global context, such as Climate Change and other environmental and social issues, the coordinated response of all the stakeholders is urgently needed. When emergency telecommunications

systems are deployed wisely, effectively, timely and in an orchestrated manner, they become key elements to accomplishing the task of assistance, support, safety and relief of affected populations.

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