

VULNERABILITY REDUCTION BY USING SOCIAL MEDIA IN DISASTERS

Twitter communications during
the Copiapó River valley floods
of 2015 & 2017



MSc Minor thesis

Vulnerability reduction by using social media in disasters

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Abstract

Social media's widespread use in the past decade has provided a new format for communications that has not only influenced how people interact, but has also led to new applications in different fields, one of them being disaster studies. Within this field, the real-time, effective dissemination of information that social media provides has been very valuable to respond efficiently to disasters and even to act before they occur. I argue that the same tool can also be used to decrease the vulnerability of people towards disasters in a certain place. This research focuses on the use of social media to build social capital as means to decrease exposure, improve capacity and resilience, and therefore to decrease vulnerability.

The methodology is based on a literature review, retrieval and analysis of data from social media, and interviews. The case study is social media communication on Twitter about two major floods that occurred in 2015 and 2017, in the Copiapó River valley in Chile. In this way, I gain insight into the evolution of a community's social media use during disasters, how this may decrease their vulnerability, and how this could contribute to disaster risk reduction.

Keywords: Social media, vulnerability, disaster, communication, social capital

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1. Introduction

Social media is part of our everyday life: we *tweet*, post, comment, follow/unfollow, like and react to the information that is constantly being uploaded into it. If we need information, or if we want to express ourselves, we resort to social media. This varies in every society, in a higher or lesser degree, but it can be stated that modern society uses social media, with 37% of the population worldwide using it (We are social & Hootsuite, 2017). In Chile, in particular, over 71% of the population are regular social media users (We are social & Hootsuite, 2017).

When a disaster happens, there is a high demand for information, as a result of the diminished communication capacity and the uncertainty produced by the threat (Houston et al., 2015). In that context, social media opens a new pathway to improve disaster communications (Houston et al., 2015; Gao et al., 2011), and contribute to emergency management (Dufty, 2016). This, in turn, can influence disaster risk reduction, by disseminating information regarding disaster response and recovery, influencing people's relation to risk (Houston et al., 2015), giving a voice to the vulnerable, improving social cohesion, and building social capital (Alexander, 2014).

As Oliver-Smith (2004) points out, disasters are socially produced: power relations shape social processes producing inequalities and different degrees of exposure to risk, rendering some people more vulnerable to disasters than others. Vulnerability is then understood in the context of political and economic systems rather than as a result of natural forces (Blaikie et al., 2014). Hilhorst adds another aspect to this understanding, by recognizing the agency of individuals in the social system, and that they are not passive actors reacting to external provocations, but "they have the capacity to process social experience and to respond accordingly" (Hilhorst, 2004, p.56).

I explore the definition of vulnerability, and its relation to social capital, in order to establish a link to social media, and study its potential use for the decrease of vulnerability, and ultimately for disaster risk reduction. I engage with two complementing vulnerability theories (Blaikie et al., 2014; Engel, 2016) that serve to frame and operationalize vulnerability. These theories recognize the multidimensionality and multi-scale feature of vulnerability, which can be related to disaster theories that recognize disasters as socially produced (Oliver-Smith, 2004), with individuals that have human agency (Hilshorst, 2004). In this context, social capital theory (Szreter et al., 2004; Ellison et al., 2006; Cai, 2017) provides a theoretical connection between the use of social media and vulnerability, by engaging with bridging and linking, which in turn relates to social cohesion (Alexander, 2014; Dufty, 2016), empowerment (Dufty, 2016), and crowdsourcing (Gao et al., 2011; Alexander, 2014; Mehta et al., 2017). *Netnographic* research alongside semi-structured interviews provides empirical evidence that supports the theories, by relating mainly to adaptation strategies and the dynamics of exclusion present in social media communications. Interviews, in particular, provide deeper insight into the understanding of vulnerability and the use of social media during disasters.

This thesis aim is to explore social media use and its potential for vulnerability reduction during disasters. The results from the *netnographic* research show the evolution of social media use during disasters, directly impacting user's vulnerability, mainly through exposure decrease, and social connections, but also hints potentially complementary aspects, such as empowerment, and crowdsourcing.

1.1. Case study: social media communication of Twitter users

The case study is social media communication on Twitter about two major floods that occurred in 2015 and 2017, in the Copiapó River valley, Chile.

The Copiapó River valley, located in the south of the Atacama Desert in Chile, is a mineral-rich area with small and medium urban settlements that harbors multiple mines and agriculture business, mainly of grapes. On March 2015, due to unusual ocean and atmospheric conditions (Wilcox et al., 2016), an extreme hydro meteorological event took place, with rains of 30mm in two days (Barrett et al., 2016) - more than the annual average - after experiencing twenty years of drought (Sturla et al., 2015). A similar, but less extreme event occurred in May 2017. In the 2015 flood, given the unawareness and unpreparedness regarding flood risks, the warning and evacuation process was improvised and sometimes inefficient. The participation on social media at the time of the event experienced minimum changes. The flood resulted in multiple casualties, and serious damages to properties. In the 2017 flood, participation in social media during the flood peaked, with updates every minute. There were no casualties due to this flood, and no serious injured, but the damage to property was considerable.

This research thesis will explore the influence of social media on the vulnerability of the inhabitants of the Copiapó River valley in Chile. Using a mixed-methods approach, a literature review and a *netnographic* study were conducted, to understand the relation between social media and vulnerability, and how the vulnerability of the inhabitants changed due to their use of social media and the repeated exposure to risk. The research questions that this thesis explores are:

1. How has social media influenced vulnerability in Chile's Copiapó valley?
 - 1.1. What factors have contributed to vulnerability?
 - 1.2. How do people use social media to be less exposed to hazards, increase their capacity, and be more resilient?
 - 1.3. What role can social media play in more effective Disaster Risk Reduction (DRR)?

1.2. Methodology

This research followed a deductive approach, combining literature review, a *netnographic* research, and semi-structured interviews. A deductive analysis “sets out to test whether data are consistent with prior assumptions, theories, or hypotheses identified or constructed” (Thomas, 2006, p.238) by a researcher. The use of a case study is suitable due to the fact that there is a lack of knowledge on a local scale about the impact of social media on vulnerability in disaster situations.

1.2.1. Data collection and analyze methods

Literature review:

I conducted a systematic search of indexed papers on the website Web of Science, using the “topic” filter. The keywords were: vulnerability, social media, disaster, ICT and a combination of them. In addition I conducted a search of each one of these keywords plus the word Chile, to access to relevant literature to this particular case study. Additionally, I reviewed relevant papers that were part of the references of the original literature.

I analyzed the content of the literature in order to identify themes that allow operationalizing vulnerability in relation to disaster. In addition, the same was done for the relation between social media and disaster.

Although multiple and sometimes contradicting theories have been written about vulnerability, the use of literature review as a research method, contributes to provide a theoretical background, and establish a link between this research and the existing body of knowledge regarding this topic, integrating the findings of this thesis into it (Kumar et al., 2005).

Netnographic research:

I conducted a *netnographic* research on social media to check specific practices identified during the literature review process, applied to the case study. *Netnography* is defined as “ethnography adapted to the study of online communities” (Kozinets, 2002, p.1). Several authors have explored the implications of *netnography* as a qualitative research method (Kozinets, 2002; Langer et al., 2005; Bowler, 2010) recognizing its wide scope, the use of new types of data, and the use of historical data as some of its main benefits. But *netnography* also presents some limitations, such as the access level to a certain social media platform (Langer et al., 2005). While some have free public access, such as Twitter, others like Facebook or Instagram can be private, limiting researchers to access the data.

I collected data in the form of *tweets* shared via Twitter because it is a simple and effective tool of communication (Juris, 2012) that works as a social media and microblogging platform. To do so, I retrieved *tweets* containing the words “tierra amarilla”, that refers to the location of one of the most affected towns during the floods. I considered a timeframe of two days, where day one was the flood, and day two, the aftermath. The time frames are: 23-25th of March 2015, and 13-15th of May 2017. The word “#tierraamarilla” was also included in the search, because of its use as a *hashtag*.

There were some specific limitations in the process of retrieving historical data from Twitter, because of the large amount of data and the high costs associated to

the use of Gnip Inc. Twitter's data manager. Because of these limitations, each *tweet* was retrieved independently, by coping its content and all the information publicly available into an Excel spreadsheet. I organized the *tweets*, including username (individual or organization), name, date, time, location, user, number of *retweets*, likes and responses, and presence or absence of links, images and videos. I then analyzed them, identifying their main use, reach, and other relevant features, so it could be operationalized, mapped, and then related to a certain aspect of vulnerability. By using data from two different floods, I gained insight into the evolution on the use of social media during disasters for individuals of a specific community, and how this could influence their vulnerability.

Semi-structured interviews:

I conducted a series of semi-structured interviews¹ to inhabitants of the Copiapó River valley between December 2017 and January 2018. The information retrieved from these interviews was used to provide this minor thesis with relevant examples that illustrate both context and social media use. Semi-structured interviews have some limitations, such as its dependability on the ability of the interviewer in order to obtain relevant results (Qu et al., 2011). Nevertheless, I chose the method because it provided a more in-depth knowledge about the case study, and flexibility to address specific aspects of a topic that were discovered during the interviews.

"[The semi-structured interview] it is flexible, accessible and intelligible and, more important, capable of disclosing important and often hidden facets of human and organizational behavior" (Qu et al., 2011, p.246).

Interviews were conducted in Spanish, and I provided all the translations

¹ The interviews were part of the fieldwork for the major thesis that was possible thanks to the grant provided by the Dutch Foundation NHBos along with the scholarship 'Becas Chile'

2. Exploring the case study: the Copiapó valley and its inhabitants' vulnerability

Disasters cannot be understood separately from the society where they occur (Hilhorst, 2013), so in order to understand the Copiapó valley floods of 2015 and 2017, it is relevant to first explore the causes of the disaster in relation to the society where it happened. The pressure and release model (PAR) developed by Blaikie et al., (2014), engages with the societal background, and political and economic systems. They argue that every disaster can be understood in terms of the relation between the progression of vulnerability (root causes, dynamic pressures and unsafe conditions), and a hazard. For the purpose of this chapter, that model is used to frame the Copiapó valley floods of 2015 and 2017.

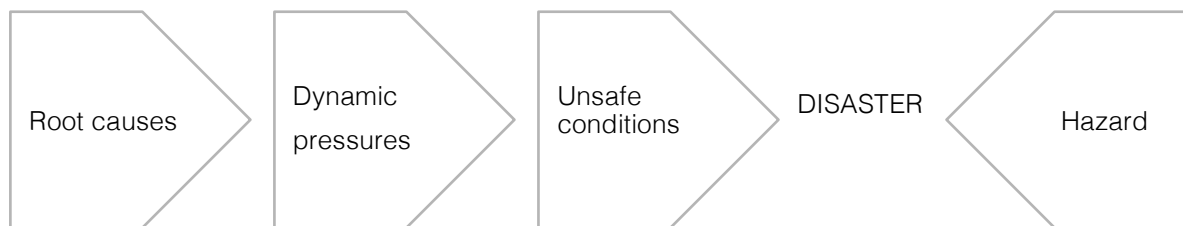


Figure 1. Pressure and release model (PAR) from Blaikie et al. 2014, p.51

2.1. Root causes: inequality

According to Bankoff et al. vulnerability “is embedded in complex social relations and processes” (Bankoff et al., 2004, p.5), with political economic forces that shape those relations. As a result, there is the production of inequalities, translated into the distribution of wealth and education, the access to power and resources, and the access to and stability of livelihoods. Globally, the GINI index is a measure of wealth distribution. Chile’s GINI coefficient is 0.47, the highest in developed countries according to OECD (Deen, 2016). Even though this coefficient

only shows relative wealth, it is relevant to get an overview of inequality levels. Nationally, this index has dropped less than 0.1 point over the past 30 years. Nationally, the socio-economic stratum (*Nivel socio-económico*) is a measure of the distribution of wealth and education, based on market research. According to the Adimark survey (Mapa socioeconomic de Chile, 2007), in the Atacama region, only 5% of households belong to the highest socio-economic stratum (ABC1), while 36% belongs to stratum D, similarly to the national situation. Both the GINI index and the socio-economic stratum distribution reflect the high degree of inequality present in the country.

Stratum D comprises households with non-technical or professional education, and with a sufficient quantity of goods. Engel (2016) understanding of the “emergent middle” fits with the description of stratum D: people who are not poor, but are very susceptible to any disruption to their current situation, which may cause them falling back into poverty. Because of their privileged position in comparison with the poor, this group is usually not the main target of social policies. Instead, national policies have been focused on the fight against poverty (Espinoza et al., 2013; Rovira, 2016). Even though the state concern is very valid, is not proactive regarding people in risk of becoming poor, but more focused on changing the situation of the people who are already poor. The focus on one group tends to see the situation as static, neglecting to recognize that people and their situation change overtime, they are dynamic.

For example, when asked about her living situation, a 60 year old woman, from the Barrionuevo informal settlement in Tierra Amarilla, bluntly stated:

“I didn’t register my partner in the community survey. They told me to say that I live by myself, because Luis works, and he earns more than me...If I want to have any kind of benefit, I cannot depend on him (economically)”.

She is referring to the survey that the neighborhood committee was preparing to present to the Municipality in order to request welfare support for the inhabitants

of the informal settlement. The dilemma of this woman portrays the situation that many families experience in this area. While they mostly have seasonal jobs with some kind of economic stability that allows them to have food on their plates and a place to live, they are in constant fear of not being perceived as “poor enough” to have access to some kind of welfare support. Unfortunately, without it they would not be able to have a comfortable living.

This example links to a wider issue of seasonal agricultural work. Historically, the main economic activity in the area and main source of income has been agriculture. During the first part of the twentieth century, up to the 1970s, agriculture consisted of small-scale farmers, with a family-based work structure and a sustainable use of water. There was also small-scale mining, with artisanal extraction methods. Since 1974, there was a liberalization of the economy during the military dictatorship (Ffrench-Davis et al., 2001), as a consequence, during the 1980s, agroindustry was established and the cultivation of vines for grape export became the new trend. This brought a new social order, with a new system of salaried workers and a new way to manage natural resources (Malebrán & Rodriguez, 2014). By the beginning of the 1990s, there was a gradual decline of agriculture, alongside the intensive growth of the mining industry. This affected not only the exploitation of natural resources - stressing even more the use of water and the degradation of the soil - but also the lives of local inhabitants, whose livelihoods previously depended on agriculture. Some inhabitants manage to adapt to the new predominant activity by changing their line of work, either towards mining or services related to it, like food or transport. In addition, many trained mining workers were brought from other parts of the country, to operate the mines. This new workforce constituted an important floating population, comparable to the size of local population. A group of workers at the San José Plant are part of this floating population. All of them are from La Serena (Coquimbo region), over 400km south of Tierra Amarilla, and while they work in Tierra Amarilla, their families and homes are in La Serena. I observed this situation in multiple occasions while visiting the

Copiapó River valley, with workers coming primarily from Coquimbo, but also from southern regions.

Considering this scenario, it is understandable that the access to power structures and resources in the valley is deeply influenced by the presence of powerful international actors, namely Lundin Mining (Candelaria mining complex) and SCM Mining Lumina Copper Chile (Caserones mining complex). Although there are municipal and provincial governments, the magnitude and financial relevance of the mining companies functions in a level that is commonly out of reach for these local agents. Decisions regarding the use of water, the building of infrastructure and use of land with ancestral value in the Andes, to name a few, are some of the conflicting issues that usually relate to higher governmental and economic spheres.

A Regional Government Adviser, is clear about the current role of mining companies in the area, stating the following:

“The mining companies became the government's substitute in a way, but I think the responsibility [of dealing with the community's problems] belongs to the government”.

He was also critical of the lack of agency of the local and regional government in comparison with central government when dealing with regional issues.

Inequality and the consequent limited access to power structures and resources constitute the main root causes. In the Chilean neoliberal system, inequality is accentuated by the presence of transnational actors that destabilize the local reality in economic and power terms. While they provide livelihood and therefore the access to resources for some people, they seem to exclude local actors from broader decision-making processes.

Overall, power structures highly depend on economical actors, who also concentrate most of the resources in the region. As both Blaikie et al. (2014) and Oliver-Smith (2004) argue, this set of relationships produces inequality, and

ultimately different degrees of exposure to risk given by the unequal distribution of resources and power.

2.2. Dynamic pressures: urban development, lack of regulation, and desertification.

Dynamic pressures in the Copiapó valley relate to both natural and anthropogenic causes of water stress (Hunter et al., 2015). The valley, located on the southern edge of the Atacama Desert, is home to some of the biggest mining operations nationally: Candelaria and Caserones mining complex. Both located in the township of Tierra Amarilla, the first in the immediate surroundings of the city of Tierra Amarilla, while the second is located higher up in The Andes. Along with the existing agro-industrial activities, and urban development, they are the main anthropogenic causes of water stress (Hunter et al., 2015), and landscape degradation.

During the past three decades, there has been increased exploitation of the water resource (Suarez et al., 2014), due to the presence of new actors with new needs, the non-regulated development of existing urban areas and rural towns, and the indiscriminate distribution of water rights.

As mentioned previously, agroindustry and large-scale mining are new activities in the valley, dating back to the 1980s and 1990s respectively. These new large-scale activities, offering new livelihood opportunities, caused the migration of inhabitants from other areas, which in turn prompted the development - sometimes informal - of urban areas. The Regional Plan for Urban Development (*Plan Regional de Desarrollo Urbano*) regulates and defines land use and risk zones, but serves only as a general guideline for development in the region. Additionally, local needs and characteristics should be addressed in local planning tools. Some areas though, are neglected by regional plans and don't have local planning tools, such

as Tierra Amarilla. Tierra Amarilla, a township and city that harbors most of the large-scale mining operations in the region, has five mines in its immediate surroundings. The proximity of the mines and the overall mining operations contribute to air pollution and water stress that in turn affects the lives of its citizens. Los Loros, another town in the valley that belongs to the same township, is under similar water stress. In the case of Los Loros though, it relates mostly to the need for resources of the agroindustry predominantly present in that area. These are just some of the existing examples, since there are smaller towns with little or no regulation dependent on the same Municipality and under similar water stress.

As for the rights system for water exploitation (*Derechos de aprovechamiento de agua*), it began in 1981 and continues to this date. It consists of the purchase of water rights by an interested party in order to make use of a certain amount of water in a certain basin, and from a specific source. It was conceived as a strategy to control the water resource, but completely disregarded the underground water tables (Hunter et al., 2015). Overtime, the water rights granted were superior to the actual capacity of the valley.

The abovementioned, along with the protracted drought that has affected the region during the past decades, has resulted in the current hydric deficit, and the continuous desertification of the land, that has hindered the growth of vegetation and has made the soil less permeable and absorbent, increasing the risks of floods and mudslides.

“Dynamic pressures channel the root causes into particular forms of unsafe conditions” (Blaikie et al., 2014, p.54). They strongly relate to space and time, allowing later on to identify very specific unsafe conditions. The changes in the landscapes as a result of urban and economical development in the region, alongside the lack of regulations and the consequent desertification, are the macro forces that conform the dynamic pressures. The main economic actors have an important influence on the development of cities and settlements, both because of the growth of the workforce and the presence of seasonal workers that have an

impact in the demands for housing. This set of variables relates to broader issues, connecting to the root causes for vulnerability, but they are bounded to the Atacama region and its history. This in turn materializes in a set of unsafe conditions.

2.3. Unsafe conditions: fragility and unawareness

Unsafe conditions are the result of the “processes and activities that ‘translate’ the effects of root causes both temporally and spatially” (Blaikie et al., 2014, p.53). For the Copiapó River valley case, this result can be summarized as: the fragile physical environment, translated into settlements on dangerous locations close to the river basin; the fragile local economy, with medium-low income levels depending mostly on mining and agriculture; and the unawareness and unpreparedness towards floods.

In order to understand these unsafe conditions, it is relevant to briefly review the characteristics of Chilean society. The military dictatorship, that took place between 1973 and 1990, influenced society in multiple ways. One of particular relevance for this case is the social interactions and the use of public space. Before the 1970s, there was a growing national cultural movement that prompted an atmosphere of collectiveness and the appropriation of the public space associated with recreation and political activity (Jara, 2004). With the start of the dictatorship, these sorts of activities relocated into the private, “domestic”, space, in an atmosphere of control and repression, full of restrictions and prohibitions regarding gatherings and the use of public space, like the curfew that was imposed in some cities for years. These limitations, while making the streets a forbidden place, over time triggered the emergence of networks and local participation (Jara, 2004). By the end of the 1980s the situation shifted, with a re-appropriation of public space as a place for contestation. The arrival of democracy, the consolidation of a neoliberal economy

and the absence of an antagonistic government, produced a new turn back to the use of private space, shaping a more individualistic society. This dominant individualism weakened the notions of community and solidarity of previous times and established a new social mobility structure based on personal efforts and merits. This arrived alongside the increase of the material quality of life at the cost of the social quality of life (Arnold-Cathalifaud, 2006).

The new social mobility, related to the individualism of Chilean society, is based on the understanding that success or failure depends on the individual and not on the aid of external agents (Arnold-Cathalifaud, 2006). In this way, Hilhorst's human agency theory takes on special relevance, by recognizing that individuals are not passive actors reacting to external provocations, but "they have the capacity to process social experience and to respond accordingly" (Hilhorst, 2004, p.56). In a society that relies more on the individual than on the collective, the human agency concept unveils an interesting opportunity for action against vulnerability. This is not a plea for neoliberalism; on the contrary, I only intend to make a point about how one of the main societal features linked to neoliberalism can become the starting point for the decrease of vulnerability, ultimately challenging neoliberalism itself. This argument is later explored in Chapter 3.2 on Social Media for Social Capital.

Under this logic, it can be said that in general Chileans look out for themselves. In a context where over one third of the population has just enough to get by, to look after oneself means that their decisions, although well intended for self-preservation, can be often limited by their resources. These limitations result in a fragile physical environment, where individuals settle where it is possible and convenient, not necessarily where it's safer. In the case of the Copiapó River valley, most settlements are located along the rivers and ravines, areas prone to floods.

Additionally, people's resources depend on their livelihood. Although the presence of agroindustry and large-scale mining companies could suggest otherwise, the Copiapó River valley seems to have a fragile local economy, depending highly on the choices of a few powerful actors.

At the beginning of the military dictatorship, Pinochet adopted neoliberalism as a development strategy, advised by the “Chicago boys”² (Connell et al., 2014), and influenced by the United States, in an anti-communist climate facilitated by the Cold War (Leal, 2003). The following quote summarizes this approach:

”It [neoliberalism] abandoned the previous strategy of industrialization, thus weakening the industrial working class and the unions based on it. It looked for growth to an expansion of export industries and found them in mining and commercial agriculture. It thus re-oriented the economy to international trade” (Connell et al., 2014, p.122)

Since the local shift from self-sufficient farmer or miner to salaried worker in the 1980s, the inhabitants of this area depend on a few powerful actors, mainly related to mining, but also to agroindustry³. In the long term, problems could arise, for example, when mining operations stop being profitable and there is a new shift or trend, with either a new activity or the modification of an existing one. Then, local inhabitants would have to reconsider again their position in society and their livelihood. In the short term, a disaster, namely a flood, can have the same effect, by affecting individuals who are not equipped to deal with it, and therefore not resilient.

The individualistic feature of Chilean society, the fragile local economy, and the unawareness and unpreparedness towards flood risk, constitute the unsafe conditions that represent the most visible stage of the progression of vulnerability for the PAR model. Furthermore, vulnerability to disasters is a matter of perception (Bankoff et al., 2005). In turn, perception is tightly related to people’s own experiences and the society they are part of. For the inhabitants of the Copiapó valley, the perception of flood risk was based on their experience living in the

² “Chicago Boys” is the name given in Chile to a group of former students of the Chicago school that later became policy makers and advisers, and advocated for neoliberalism (Connell et al., 2014).

³ The main agro-industrial production in the area is grape, and the main market for it is the United States, according to the local farmers that were interviewed.

desert. Therefore, they were not aware of or prepared for floods. Not only local inhabitants were not prepared, but neither were the authorities, who struggle to first acknowledge and then respond to the disaster.

In summary, the dictatorship that affected the country for 17 years, alongside its neoliberal approach penetrated all layers of society, influencing social relations, economic growth, power structures, and overall contributing to a higher inequality, all of which contributed to the presence of vulnerability. These processes not only affected people's livelihoods and their access to resources, but also transformed the landscape. It seems though, that this went unnoticed, and people were not aware of risks, becoming extremely vulnerable. The occurrence of a hazard in this context sets the scene for the occurrence of a disaster. In order to release pressure from it, it is necessary to address vulnerability as a whole, recognizing that is multidimensional and multi-scale. "In short, PAR needs thorough research that is locally and historically based" (Blaikie et al., 2014, p.54).



Image 1. Inhabitant of Tierra Amarilla who lost her house during the 2017 flood.

Source @PiensaPrensa

2.4. The hazard: extreme precipitations, floods and landslides in Atacama



Image 2. House entrance in Tierra Amarilla after the 2017 flood.

Source @uliseshuilcal

On 24th of March 2015, 10mm of precipitation were observed in the Atacama region, and twice that the next day, influenced primarily by extreme warm surface temperature anomalies registered along the country (Barrett et al., 2016). Considering that annual precipitations in that area are no more than 28mm (Suarez et al., 2014) with “large inter-annual variation due to El Niño” (Hunter et al., 2015 p.5938) the precipitations that day caused floods and landslides that affected the settlements along the valley. Most of the damage within the Copiapó River valley happened either in areas closer to the river basin or upstream, where the valley gets narrower, and any disruption in the transport infrastructure leaves towns isolated. This flood was instrumental in triggering changes in the way the inhabitants of the valley perceive flood risk and understand their vulnerability to it. In 2017, similar circumstances resulted in another flood.

3. Social media and vulnerability

3.1. Vulnerability: exposure, coping capacity and resilience

There are multiple theories about vulnerability with different focus: the identification of different dimensions of vulnerability (Wilches-Chaux, 1989); the definition of vulnerability in terms of exposure to shocks, inadequate capacity to cope with them, and the potentiality to recover (Bohle et al., 1994); the understanding of vulnerability as the susceptibility to damage in case of a destabilizing event (Cardona, 2004); the understanding of social vulnerability in terms of a differential impact to people according to their characteristics (Cannon et al., 2003); vulnerability and resilience as separate but linked terms (Cutter et al., 2008); and vulnerability as the progression of root causes, dynamic pressures, and unsafe conditions (Blaikie et al., 2014).

This last theory understands vulnerability in the context of political and economic systems, providing a broad definition for it, but neglecting to emphasize the role of individuals. Engel (2016) drawing on Bohle et al. (1994) theory, narrows down the concept of vulnerability, defining it in terms of exposure, capacity and resilience. Each one of these terms relates not only with the individual, but also to the society where he/she belongs, and the global processes that influence them. This definition provides a new layer of knowledge about vulnerability in the Chilean context that complements the theory of Blaikie et al. (2014)

In this context, exposure is understood as a term that has both a material and immaterial aspect: it can refer to spatial exposure, such as proximity to a risk area, but also, for example, to social exposure, such as exclusion from a social network (Birkmann 2006; Bohle et al., 1994, Cannon et al., 2003; as cited by Engel, 2016). The latter is especially relevant when analyzing the influence of social media in the decrease of vulnerability, because it recognizes the importance of social networks and its direct impact in vulnerability.

Capacity, also understood in this context as coping capacity, has been previously defined as the ability to cope with stress and shocks (Bohle et al., 1994). Chambers (1989) work adds to this definition by proposing that coping strategies vary according to location, social group, and other factors. He also refers to how people who are in vulnerable situations generally become more adaptable, when faced with the impossibility of reducing the risk they are exposed to. More recently, UNISDR complemented these definitions by referring to capacity as the “means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a disaster” (UN/ISDR 2004, p16).

Resilience has many definitions, going back as far as 1973 with Holling’s ecological definition of the resilience of an ecosystem and its ability to absorb changes (Mayunga, 2007). Other definitions include resilience as “the ability of an actor to cope with or adapt to hazard stress” (Pelling, 2003, p48). This definition addresses coping and adaptation, but sees them as two separate strategies that exclude one another, while in reality adaptation can be also understood as a way of dealing with a shock. In recent years, Pelling (2010) has focused on transformation over resilience, advocating for challenge instead of coping. This new angle, although interesting, it is not explored in this thesis. It is relevant to note that the term cope is used in this thesis to refer to all approaches towards disasters, including both active and passive. “Coping is the manner in which people act within the limits of existing resources and range of expectations to achieve various ends.” (Blaikie et al., 2014, p.113)

After the review of some of the existing theories and definitions about vulnerability, I argue that these three terms are not to be understood in isolation as different parts of one whole, on the contrary, they intertwine and work always in combination. Therefore, in order to analyze how can social media influence vulnerability, I use exposure, capacity and resilience combined; understanding that any variable that affects one of them, affects the others. In specific, I focus in

vulnerability observed through adaptation strategies (or lack thereof) in the use of social media communication and the dynamics of exclusion taking place there.

3.1.1. Adaptation strategies

Adaptation strategies for communications between 2015 and 2017 evolved, partly in proportion to the resources those individuals had. When interviewed about it, inhabitants of vulnerable neighborhoods in Tierra Amarilla stated that in 2015, warnings came first from other neighbors. Angela (39), from the Barrionuevo informal settlement, said:

“They (neighbors) were going around warning people, saying that the [water through the] ravine was coming, so all of us, all the neighbors, headed straight to the hill”.

Other neighbors commented that they were also warned by their relatives via Whatsapp (smartphone application similar to text message) about what was going on with the river and the ravines in the area. In the town of Los Loros, neighbors from Raul Silva Henríquez neighborhood commented that the warnings also came first from the neighbors and via Whatsapp, but telecommunications crashed soon after due to the excessive rain. Then, the only means of communication with the outside world were two satellite radios, one at the police station and one at the emergency room. These limitations forced the people to rely mostly on their own community in order to cope.

When comparing the 2015 and 2017 floods, in both these cases the means of communications remained similar, with the inhabitants themselves being the first channel for the dissemination of information, along with Whatsapp. Additionally, according to neighbors, the telecommunication system in Los Loros was improved, helping to allow Whatsapp communications and other social media for a longer time in case of future disasters.

In contrast, a member of the local water board (Junta de Vigilancia del Río Copiapó y sus afluentes) described his experience during both floods, and what kind of adaptation strategies they adopted in order to decrease their vulnerability in the face of disaster:

“On the 23rd, our meteorologist warned us that it was going to rain 40mm, and that doesn’t normally happen in here, so it was serious... So we close the canal network, the reservoir was empty, so we closed it completely. In the early morning of the 25th is when everything unraveled. I was calling to the reservoir, but the signal was dead, so I couldn’t communicate with them... So, the second time, we learned our lesson. After the flood and mudslide of 2015, we fixed the reservoir, added telemetry, published the information in local radios, we bought satellite phones, etc. Then, when the second flood came, we were less stressed, everything was working and we were also on social media...Did you notice the antenna here? Even if the telecommunication system fails, we are never incommunicado. We also have a computer to remotely open or close the reservoir. So we are at ease.”

It is important to note that the local water board is an organization that guards and monitors the watercourses related to the Copiapó River, so they constitute a wide network of vigilance, and they have the most accurate information regarding the state of all the existing watercourses in the valley.

While inhabitants of informal settlements, some of the most vulnerable, based their disaster communications on a low-tech word-of-mouth system, other users with more access to resources, such as the local water board, adapted their communications by adding more technology, and using social media more efficiently. That included a constant presence in social media (Facebook and Twitter), and an informal Whatsapp group with other relevant users in case of disaster.

When focusing on adaptation strategies for social media communications, specifically on Twitter, I observed that there was a shift between 2015 and 2017.

Firstly, there was a significant increase in social media communications: while in 2015 only 111 tweets were retrieved (96 tweets including the keywords “tierra amarilla” and 15 tweets including the *hashtag* #tierraamarilla), in 2017 that number increase to 587 tweets (366 with the same keywords and 221 tweets with the same *hashtag*). Secondly, there was an increase in the *tweets* containing visual content (Figure 2), that in turn had an impact on the reach of those *tweets*.

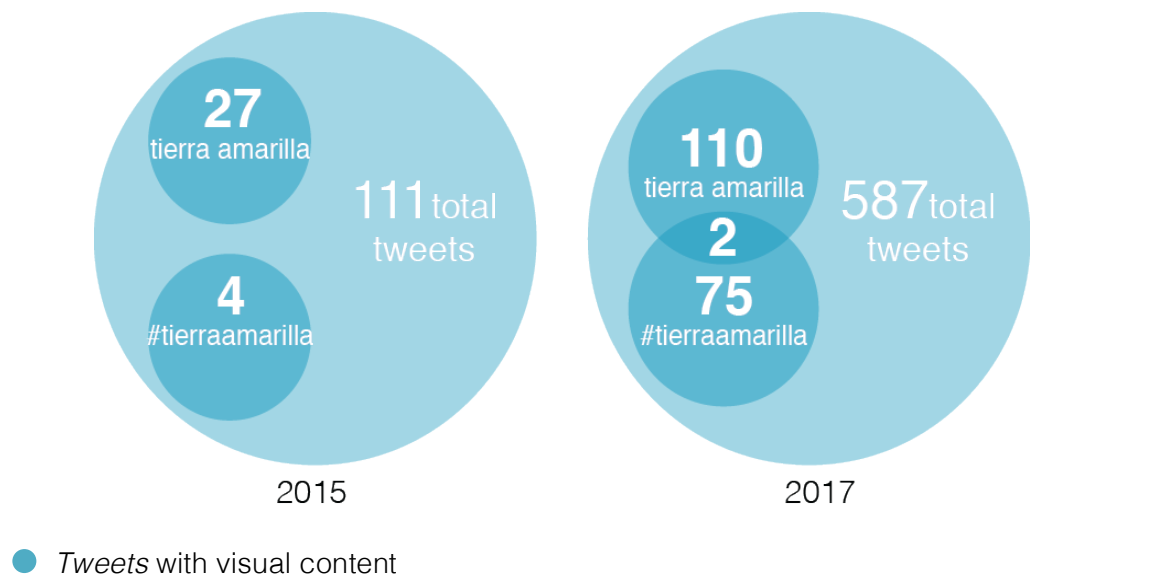


Figure 2. Diagram of tweets containing visual content according to keyword/*hashtag*

Tables 1 and 2 show the *tweets* that included visual content (video or image) and had the highest amount of likes and *retweets*. The number of likes and *retweets* serves as an indicator of the reach of a single *tweet*, understanding that every time a user likes or *retweets* the *tweet* posted by another user, an interaction occurs. The amounts of responses to each *tweet* were not considered since the number was too low to draw any observation from it.

Table 1. Most liked *tweets*

User	Date	Time	Tweet (original)	Tweet (English)	Likes	Visual content	Searched keyword/hashtag
@PDI_Atacama	13/05/2017	10:41	[Ahora] Detectives de #Copiapo trabajan evacuando adultos mayores y mascotas que se encuentran aislados en sector rural de #TierraAmarilla	[Now] #Copiapo detectives evacuate seniors and pets that were cut off in the rural area of #TierraAmarilla	272	Image	#tierra amarilla
@alegriagonzaa	14/05/2017	15:43	#Atacama Bomberos rescatando animales en Tierra Amarilla @carolinapinoc @PerrosPlazaHu em @lindorfovet @kattykowaleczk o @reddeemergen cia	#Atacama Fireman rescuing animals in Tierra Amarilla @carolinapinoc @PerrosPlazaH uem @lindorfovet @kattykowalecz ko @reddeemerge ncia	118	Image	tierra amarilla
@reddeemerge ncia	24/03/2015	9:37	Via @gafafi: Gracias a la tormenta hoy tenemos río en #Atacama #TierraAmarilla	Via @gafafi: Thanks to the storm today we have a river in #Atacama #TierraAmarilla	64	Image	#tierra amarilla
@INFORMADO RCHILE	24/03/2015	9:59	Via @gafafi: Gracias a la tormenta hoy tenemos río en Atacama Tierra Amarilla	Via @gafafi: Thanks to the storm today we have a river in Atacama Tierra Amarilla	33	Image	tierra amarilla



Image 3. Image belongs to the most liked *tweet*. Source Twitter @PDI_Atacama



Image 4. Image belongs to the second most liked *tweet*.
Source Twitter @alegriagonzaa

It is interesting to note that from the four users that appear on Table 1, only @alegriagonzaa is a private individual, while the rest are organizations: @PDI_Atacama is the official Twitter account of the investigation branch of the Police (*Policía de Investigaciones* in Spanish); @reddeemergencia is the Twitter account of a national non-profit organization who collaborates with the state in the dissemination of information regarding disasters; and @INFORMADORCHILE is an online news platform. A similar situation is observed on Table 2, where all four users are organizations: @ORCACHile is the Twitter account of a non-profit organization for the defense of the ecosystems; and @rneatacama is the local branch of @reddeemergencia.

Table 2. Most *retweeted tweets*

User	Date	Time	Tweet (original)	Tweet (English)	Re tweets	Visual content	Searched keyword/hashtag
@ORCACHile	13/05/2017	2:36	<i>Preparando todo para salir a ayudarlos! Ahora evacuen y resistan. Somos chilenos y podemos con todo</i> #TierraAmarilla #Copiapo #Chañaral #Atacama Audio del señor gobernador fe #chañaral don Yerko Guerra	Preparing everything to go and help you! Now evacuate and hold on. We are Chilean and we can face anything #TierraAmarilla #Copiapo #Chañaral #Atacama Audio from the Governor of #Chañaral Mr. Yerko Guerra.	167	Image	#tierra amarilla
@rneatacama	13/05/2017	1:09	<i>Además, tierra amarilla salida de río copiado en el pueblo de hornitos</i> Via @gafafi: Gracias a la tormenta hoy tenemos río en #Atacama	Plus, Tierra Amarilla Copiapó River at Hornitos town Via @gafafi: Thanks to the storm today we have a river in #Atacama	138	Video	tierra amarilla
@reddeemergencia	24/03/2015	9:37	<i>Gracias a la tormenta hoy tenemos río en #Atacama</i> Via @gafafi: Gracias a la tormenta hoy tenemos río en Atacama	Thanks to the storm today we have a river in #Atacama	124	Image	#tierra amarilla
@INFORMADORCHILE	24/03/2015	9:59	<i>Tierra Amarilla</i>	Thanks to the storm today we have a river in Atacama	64	Image	tierra amarilla

Overall, there is a clear shift in the use of Twitter when comparing both periods. While the use of the social media platform on 2015 was limited, in 2017 it is observed that users were actively participating, not only reporting from the site of the event but also adding visual information in order to give a more accurate description of the events taking place. The shift in use is interpreted as an adaptation strategy, intending to give a better and more efficient use to the social media platform in the face of a second flood.

3.1.2. Dynamics of exclusion

As pointed out previously, social exposure relates to certain dynamics of exclusion that take place in social networks. According to several authors, social media contributes to build social capital and to improve social cohesion by fostering a sense of belonging to a certain community (Alexander, 2014; Dufty, 2016). In addition, social media is also seen as a facilitator for what is called networked individualism: a sparsely knit network, linking individuals with little regard to space (Wellman, 2001). The creation of these online social networks, could pose significant benefits for communications, but the mere fact that associations are established, means that there is the risk of exclusion. Moreover, Portes and Landolt (1996) address exclusion as the downside of social capital. While they recognize some of its advantages for a wide range of social problems, they also argue that by benefiting members of a certain group, it excludes the ones that are not part of that group. In this context, one of the biggest limitations of social media as a management tool during disaster events is that it doesn't ensure maximum reach beyond the digital world. Nevertheless, when analyzing these dynamics within Twitter users, it can be argued that something else occurs. In this platform, anyone who is a user can participate in the network. This can be done actively, by following other users, *retweeting*, liking or responding to a *tweet* another user posted; or

passively, by just reading *tweets*. Even though passive participation may present a problem when corroborating the actual reach of a *tweet*, Twitter is an inclusive platform, highly valuable due to its capacity to connect users – people or organizations – that don't share or have ever shared a geographic location. It could potentially bring together users from different locations, socio-economic stratum, ages, etc.

It is relevant to note though, that within the retrieved tweets, there was no social media communication from the central government or mining companies in the region. The lack of social media participation of these powerful actors, could be telling about another layer within the dynamics of exclusion: it could indicate an existing boundary between them and local actors that the use of social media hasn't been able to cross. In addition, this lack of engagement on social media, could contribute to uncertainty and to a diminished situational awareness (Silver, 2016) by local inhabitants affected by the flood, which in turn could also facilitate the presence of unreliable information on social media.

3.2. Social media for social capital

The occurrence of a disaster brings great uncertainty and a diminished communication capacity (Houston et al., 2015). As a result, there is a high demand for information. In this context, social media can play an important role in the dissemination of information and in communications, by connecting both people who share the same location and those who are geographically disperse.

Twitter, in particular, not only works to this end as a social media platform, but it is also used as a micro-blogging platform. Because of the lack of limitations regarding the information that is being *tweeted* (except for the 140 character limit per *tweet*), Twitter is a very effective platform to share information in real time, and to everyone who is interested in getting that information. Twitter works also as a new

type of social connection, by not only reaffirming existing physical connections, like other platforms such as Facebook usually do, but also establishing new connections between individuals. These new connections contribute to build new social networks, characterized by a flexible networked individualism as oppose to the traditional “hierarchically arranged, densely knit, bounded groups” (Wellman, 2001, pp1).

In Chilean society, individualism is a notorious feature, consequence of the liberalization of the country’s economy and the dictatorship that ruled it for almost two decades. According to Arnold-Cathalifaud (2006), the individualism of Chilean society brought a new type of social connectivity of passive isolated spectators. Even though this understanding can be accurate for certain situations, I believe it doesn’t reflect the reality of social media communications. Instead, I argue that individualism, as a societal feature, is what makes social media so fruitful in Chile, and potentially a suitable tool for disaster risk reduction.

Based on the *netnographic* study and the interviews, users of social media are active individuals. Their first action is to be a part of certain social media platforms, which immediately connect them to a social network. That social network changes over time, as new relations are established or old ones are terminated (Ellison et al., 2007). From there, an individual’s actions can go from passive observation of online content, to active participation posting/*tweeting* content, or liking or replying to content another user posted.

The actions individuals carry out during disasters are based on formal and informal reliance on their social networks. That capacity to engage in social media reflects their human agency, understanding it as the ability “to cope with disasters, adapt to their environment and strategize” (Warner et al., 2002, p.7).

It has been previously establish by other authors that social media contributes to build social capital (Ellison et al., 2006; Alexander, 2014; Dufty, 2016). A common understanding is that social capital refers to “the trust, social norms, and networks,

which affect social and economic activities” (Nakagawa and Shaw 2004, as cited by Cai, 2017, p.1171). Moreover, some authors recognize three types of social capital: bonding, bridging and linking (Szreter et al., 2004; Ellison et al., 2006; Cai, 2017). While bonding social capital refers to connections between individuals of the same social group, bridging and linking refer to connections that reach outside that group. Bridging refers to the construction of a horizontal connection between individuals with different background, while linking is a vertical connection between individuals and powerful actors, providing access to power structures and institutions (Szreter et al., 2004; Hawkins et al., 2009). Through use of social media, extending bridging and linking social capital may contribute to decrease the vulnerability of individuals in a certain network (Cai, 2017).

Ellison et al. (2007) emphasizes the importance of internet-based connections for the creation of loose or weak ties, as a foundation of bridging social capital. He also argues that new forms of social capital will occur online, allowing people to “create and maintain larger, diffuse networks of relationships from which they could potentially draw resources” (Donath & Boyd, 2004; Resnick, 2001; Wellman, 2001; as cited by Ellison et al., 2007, p.1146). In addition, those weak ties allow a latent tie connectivity that is not yet socially active (Haythornthwaite, 2005), or they facilitate maintained social capital through which connections on a certain social network are kept after physically disconnecting from it (Ellison et al., 2007). In the case of Twitter, I argue that such latent tie connectivity is operationalized as one user following another. That way, both the user followed and the follower are aware there is a constant connection, with the possibility of engagement. As I observed during the *netnographic* study of the Copiapó River valley floods, usually this connectivity becomes active during disasters, with the disaster acting as a catalyst for social engagement online. If that engagement occurs, then there is bridging of social capital. For this case study, bridging social capital is operationalized as the amount of *retweets* and likes of each *tweet*. Even though multiple individuals are constantly

users of Twitter, this active engagement may facilitate social cohesion by enhancing the feeling of belonging to a certain online social network.

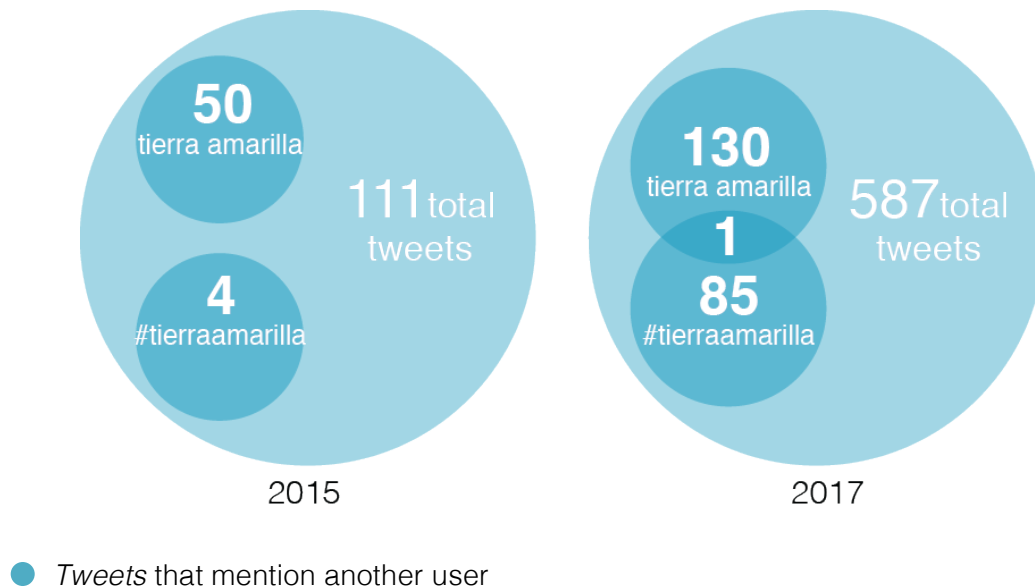


Figure 3. Diagram of *tweets* that mention another user

When one user mentions another on Twitter, that action provides an opportunity for engagement that can be understood as the potential for linking social capital (Figure 3). It will only become linking social capital if not only a connection is established, but there is also a reciprocal engagement between an individual and another more powerful one or an institution. That vertical connection opens the possibility for empowerment, allowing Twitter in particular, and social media in general, to be a tool for community empowerment (Kaminska and Rutten, 2014; as cited by Dufty, 2016).

The use of Twitter between the 2015 and the 2017 floods changed, and that adaptation impacted the amount and quality of the connections that were originally established. Figures 4 and 5 illustrate the changes on the use of Twitter between 2015 and 2017, based on the connections made to the three most mentioned users. In 2015, those users were @gafafi (private user), @radionostalgica (radio station)

and @emelat_sos (energy company). On 2017 those were @reddeemergencia (non-profit organization), @T13 (news channel), and @radionostalgica. While in 2015 the network was based mainly on single connections, in 2017 it became more complex, with a bigger number of users with multiple connections, and multi-actor connections.

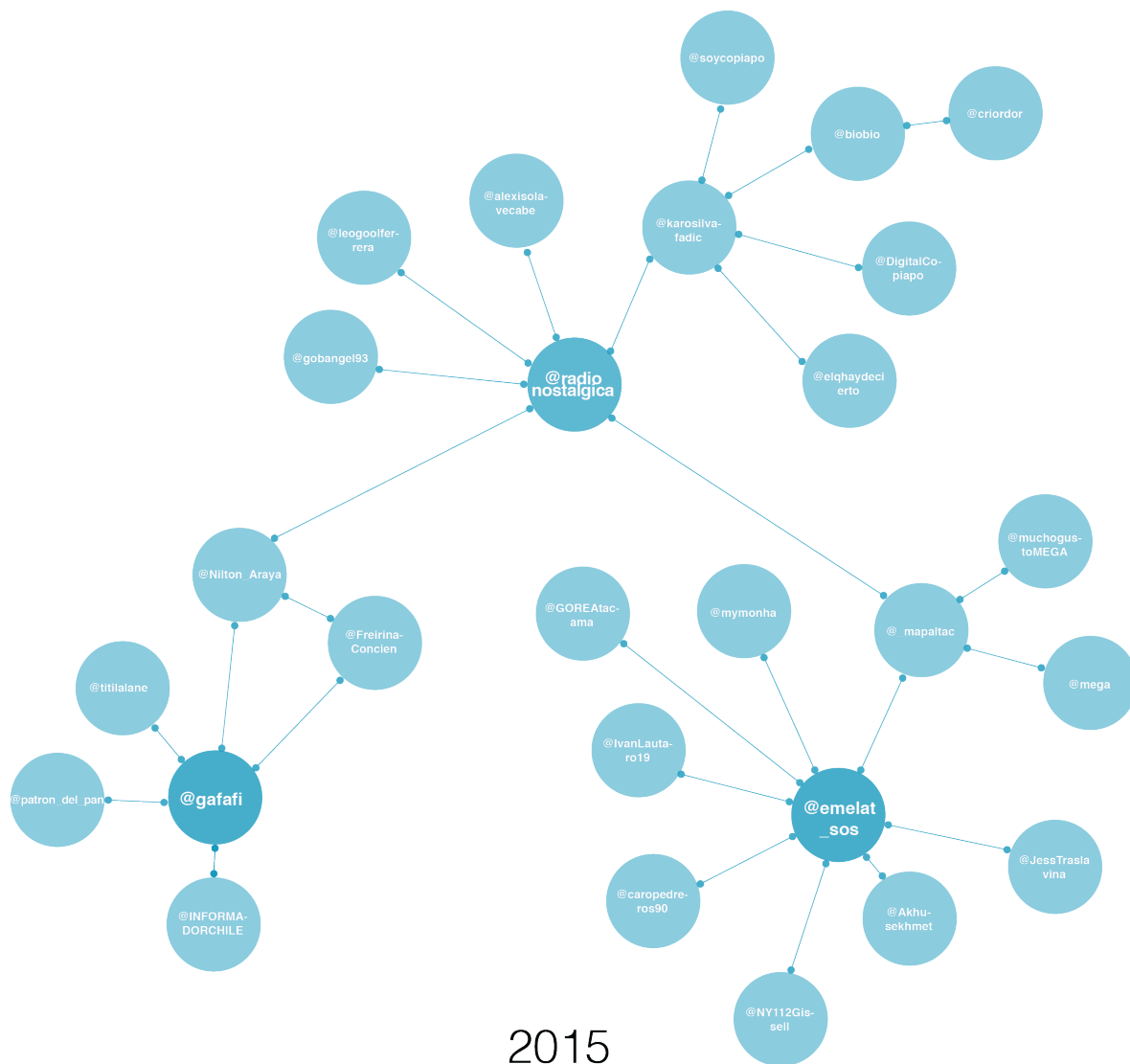


Figure 4. Diagram of the network of the three main Twitter users in 2015

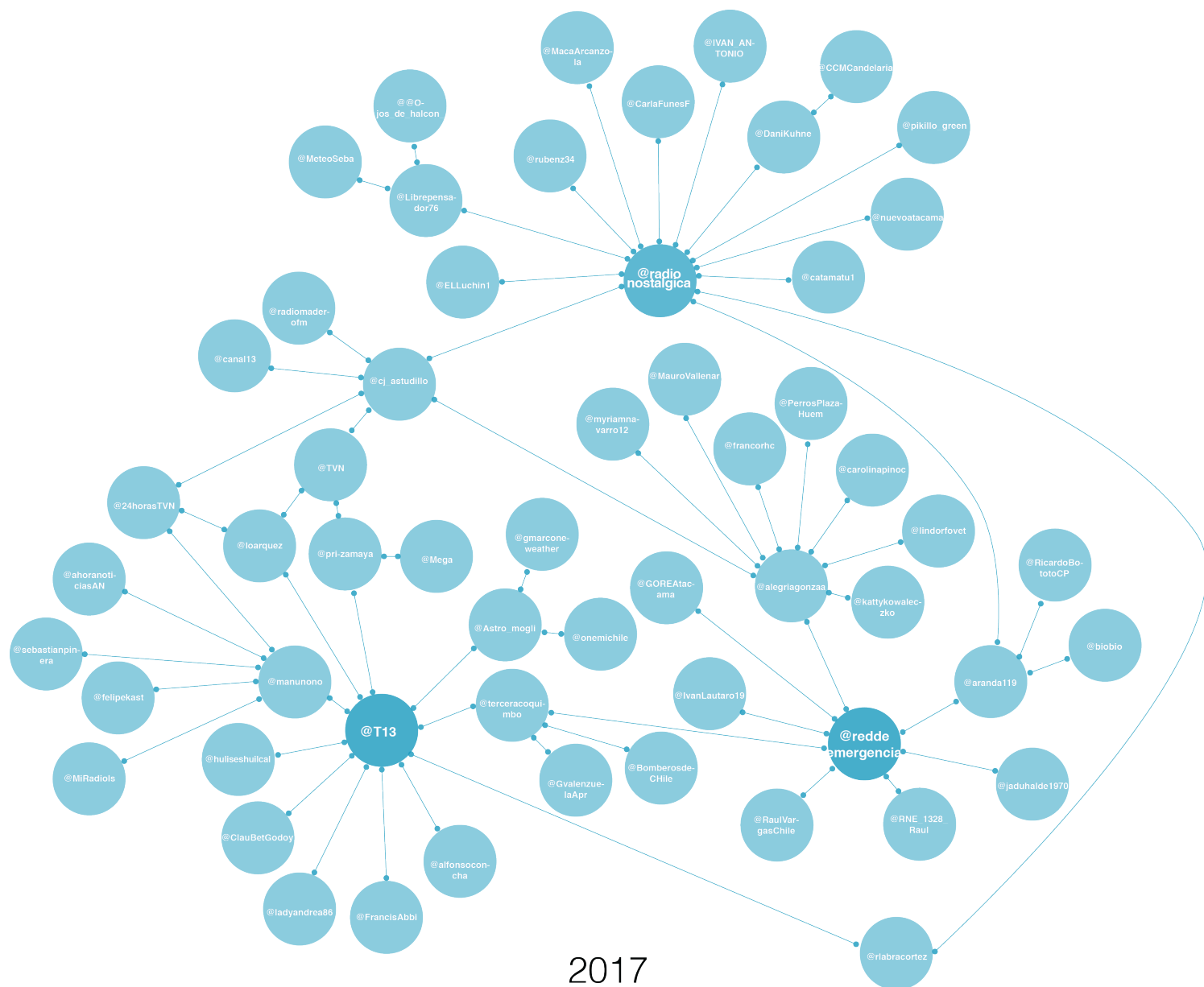


Figure 5. Diagram of the network of the three main Twitter users in 2017

When reviewing specific interactions between users, I observed many attempts from users to engage in linking strategies, with different results that seem to correlate with the aim of the tweet. In figure 6, we can see a failed attempt by a private user to connect with the president. The user @pikillo_green scolded the current president Michelle Bachelet through her official account, because of her lack of initiative in the construction of adequate infrastructure to prevent floods, and the fact that she was trying to blame climate change as a cause for the flood. The tweet had no reply from the government, and it didn't get many reactions, thus failing to build linking social capital.



Figure 6. Source Twitter @pikillo_green



Figure 7. Source Twitter @oscerhxr

A more effective and relevant example is the communication that took place between another private individual user and a politician (Figure 7): @oscarhxr directly named @LavinJoaquin in a tweet, asking for help. The username @LavinJoaquin is the official account of Joaquín Lavín, the mayor of Las Condes, a Chilean city in the metropolitan area of Santiago, with a population predominantly from the high socio-economic stratum. Following the initial tweet requesting help, @LavinJoaquin replied “We will do it” (*Lo haremos*, in Spanish). This simple interaction illustrates a linking strategy that contributes to the building of social capital, by making a new connection between an individual of a certain group with another from a more powerful group.

Another aspect of the use of social media to build social capital is crowdsourcing (Gao et al., 2011; Alexander, 2014). There are several platforms designed specifically for this purpose worldwide, like Ushahidi, but more popular

social media platforms such as Twitter can be also used as a crowdsourcing platform during disasters. For example, Twitter has been used to detect earthquakes as part of a citizen empowered seismology (Earle et al., 2012). The main value of crowdsourcing in these kinds of social media platforms is that it is based on direct and spontaneous contributions from users. Because their use is constant and not limited only to the duration of the disaster, they provide a valuable opportunity for action towards community-based disaster risk reduction. Moreover, social media as a crowdsourcing mechanism during a disaster provides aggregate situational awareness, new communications pathways, and assistance on an individual level (Gao et al., 2011).

4. Social media for Disaster Risk Reduction: Community based Disaster Risk Reduction (CBDRR)

The possible applications of social media platforms for disaster risk reduction (DRR) are probably as many as the uses social media has. Its successful application though, is defined by multiple factors, such as trust, correct and efficient use, and the reach or popularity of that platform, to name a few. These constrictions don't necessarily hinder the performance of social media; rather they can be used to define the best and most suitable use for a certain platform. Community based disaster risk reduction (CBDRR) in particular is characterized by empowerment and crowdsourcing, making the most of the participatory capacities of social media.

As pointed out during the interviews, Whatsapp communications were very popular during both floods. This allowed people to rapidly access information regarding the state of the floods, the status of their relatives, friends and neighbors, and even the allocation of aid. Overall the floods created a sense of community that in some cases wasn't there before. Even though this type of social connection provided individuals involved with a sense of security and awareness about risk, it excluded whoever was not a part of that social network. On the other hand, open

social media platforms such as Twitter provide an inclusive, participative, and real-time tool to address disaster risk reduction. The downside is that the immense amount of users and information being uploaded to the platform raises trust issues among users regarding the reliability of the information. Mehta et al. (2017) argues that in this situation, crowdsourcing serves as a verification process that allows and promotes a trust relation.

Disaster risk reduction (DRR) is usually conceptualized in a series of stages that overlap in a continuous cycle. Those stages are commonly known as: mitigation, preparedness, warning, response, and recovery, and can be also identified in CBDRR. Within each one of those stages, Dufty (2016) recognizes a series of social media uses, especially present during the stages of warning, response and recovery. Drawing on both Dufty and Alexander (2014), I developed a timeline analysis of the use of the Twitter *hashtag* #tierraamarilla during the 2017 flood. This timeline provides a better understanding of the social dynamics that took place, and illustrates some of the strengths and weaknesses of Twitter for CBDRR. Because of limitations of time and the data collection method, I mapped only the first 48 hours of the flood that correspond to the warning and response stages. The analysis combines the purpose of the social communication that took place (*tweet*) with bridging and linking social capital. The purpose of the *tweets* are coded as follows:

Table 3. Categorization of *tweets*' purpose according to source

Purpose	Source
Coordination of emergency resources	Dufty (2016)
Situational awareness	Dufty (2016), Vieweg et al., (2010)
Crowdsourcing and collaboration regarding information	Alexander (2014), Dufty (2016)
Disaster reconnaissance	Dufty (2016)
Navigating to safety	Dufty (2016)
Conduct search and rescue	Dufty (2016)
Listening and support	Alexander (2014), Dufty (2016)

Each *tweet* is coded according to these categories, or a combination of them. In addition, bridging, understood as the increase of social cohesion, is operationalized by the simple interaction between users through *retweets* and likes. Linking on the other hand, understood as a strategy for empowerment, is operationalized by an active interaction with other more powerful users, such as organizations or institutions. This is done by using @ on the *tweet* to refer to another user. It is important to note that unlike with *retweets* and likes, when a user refers to another by using @, the user mentioned receives a direct notification. The timeline analysis is split in two parts, according to the presence or absence of a linking strategy, so both bridging and linking are clearer.

By focusing first only on the frequency of the tweets, I observed that the peak in participation on Twitter was during the first hours of the flood, declining in the following hours (Figures 8 and 9). Active participation during the first critical hours of a disaster is crucial when trying to explore the potential capacities of Twitter. Nevertheless, permanent participation from key local actors is necessary to reinforce local capacities and ensure the most efficient use of Twitter for community based disaster risk reduction (CBDRR).

Currently, for example, the local office of the National Emergency Office (Oficina Nacional de Emergencia, ONEMI) doesn't control their social media. Instead, ONEMI's headquarters are the ones in charge of curating and publishing any content regarding disasters across the country. Since one of the main advantages of social media use is to share content in real-time, through use of a mandatory intermediary experts on site are not able to disseminate real time information, which hinders the performance of social media as a CBDRR tool. Timely information could contribute to close the gap between different understandings of a disaster, and could increase individuals' situational awareness, by being up to date with official information regarding the situation in which they are.

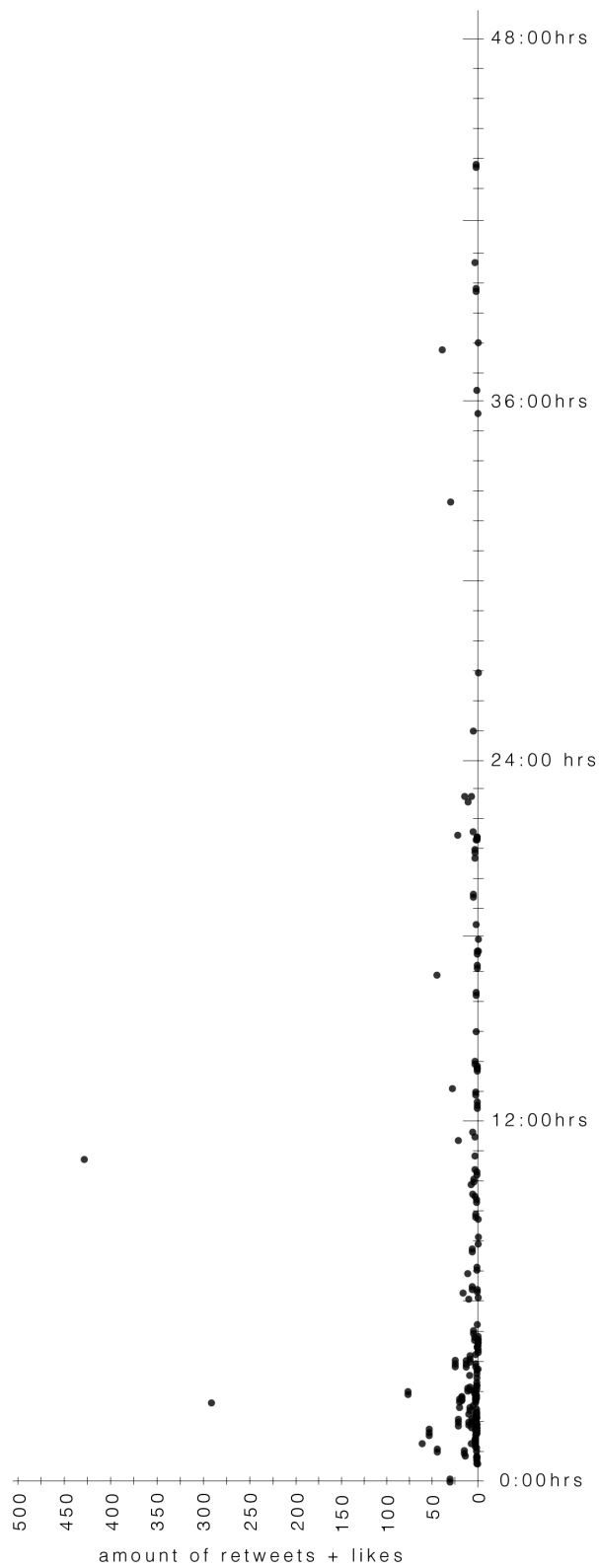


Figure 8. *Tweets* with no reference to another user

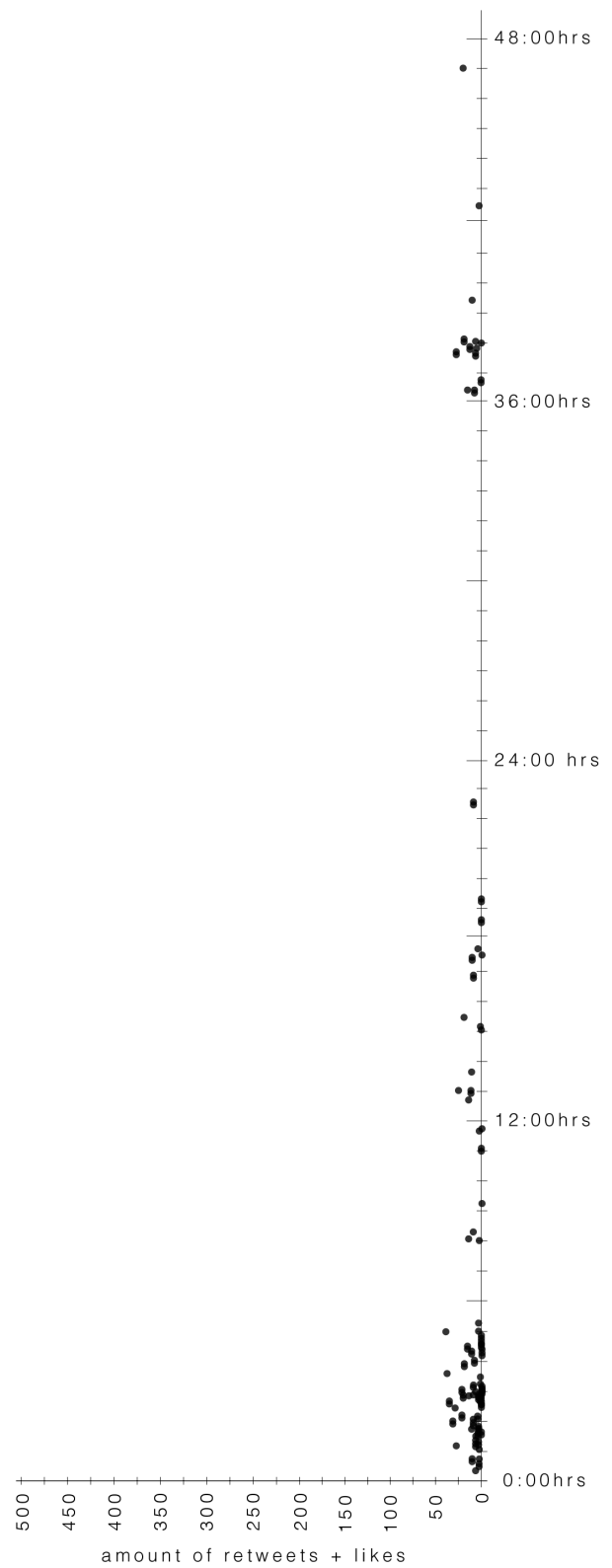


Figure 9. *Tweets* that refer another user (@)

In contrast, and as part of their learning experience, the local water board took a different approach. After 2015, they not only increased their social media presence on Facebook and Twitter, with periodical updates including visual content, but they also turned to mass media as a complementary approach. They did this by partnering with two local radios, and provided them with constant updates about the status of the watercourses in the valley. It is relevant to note, however, that this is a local organization and therefore they only have local agency and don't respond to a central organization, in contrast to the case of ONEMI.

From figure 9, I observed that there is an increase in the amount of *tweets* and their reach after hour 36. The information is insufficient to distinguish a trend, but after analyzing the content of the *tweets* and the users who posted it, I can infer that the reason behind this result is the sudden involvement of different governmental organizations at the same time. Those organizations are the Regional Government of Atacama (@GOREatacama), the Regional Office of Home Office (@SeremiGobierno3), and the investigation branch of the Police (@PDI_Atacama).

Figures 10 and 11 show in detail the codification of the tweets according to their purpose for the first 24 hours of the flood, when the engagement in Twitter was higher.

Based on figure 10, which includes *tweets* that don't refer to another user, I observed that there is constant *tweeting* during the first 23 hours of the timeline. *Tweets* coded as "listening and support", "situational awareness", and "crowdsourcing and collaboration" were generally present along the timeline, with a distinctively higher reach during the first six hours. The presence of *tweets* coded as "coordination of emergency resource" was weaker, with only four *tweets* with a reach over 25. Overall, there are only two tweets with a reach over 250. Those *tweets* were addressed in Chapter 3.1.1, on Adaptation strategies.

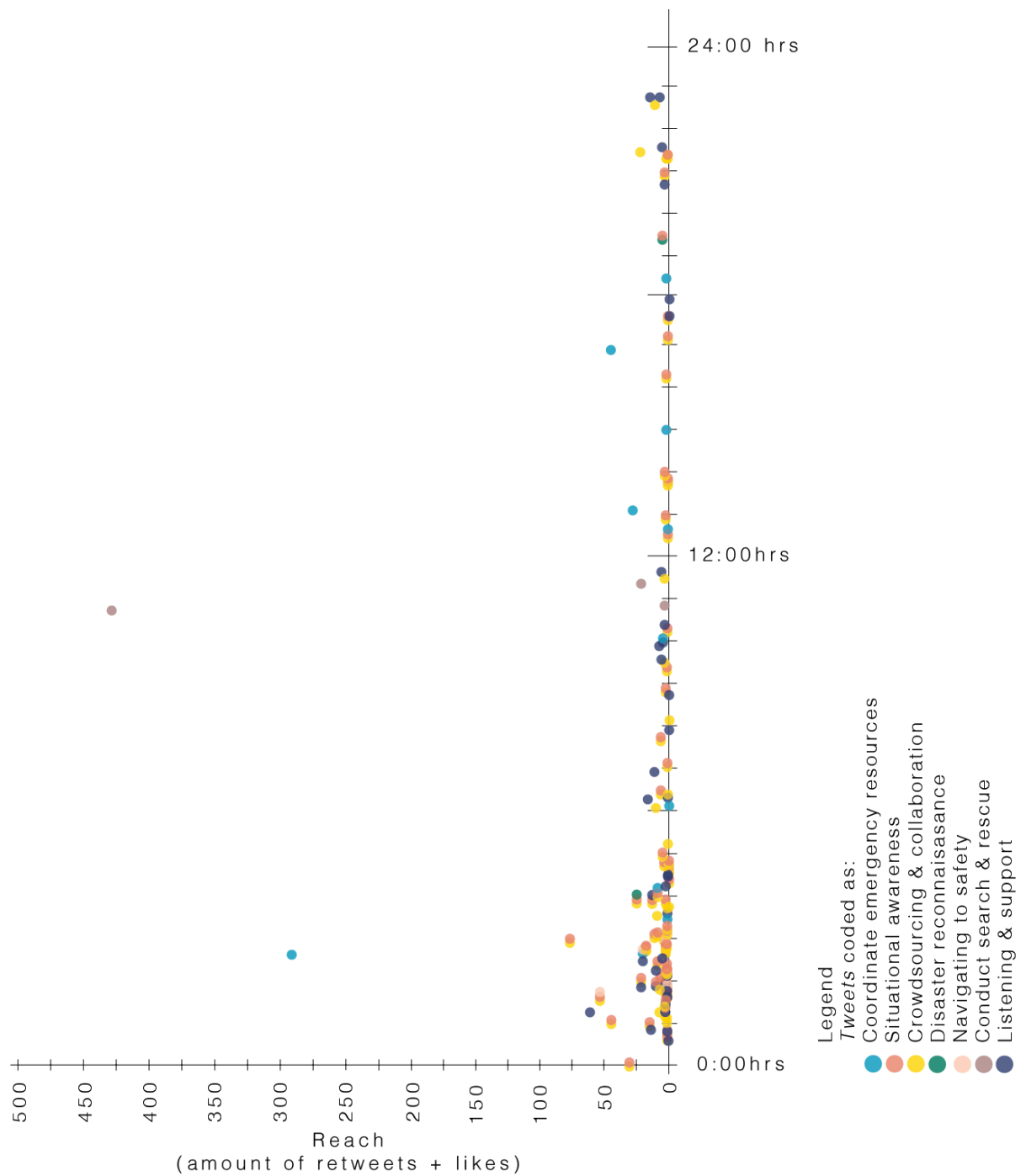


Figure 10. *Tweets* according to their codification that don't refer another user

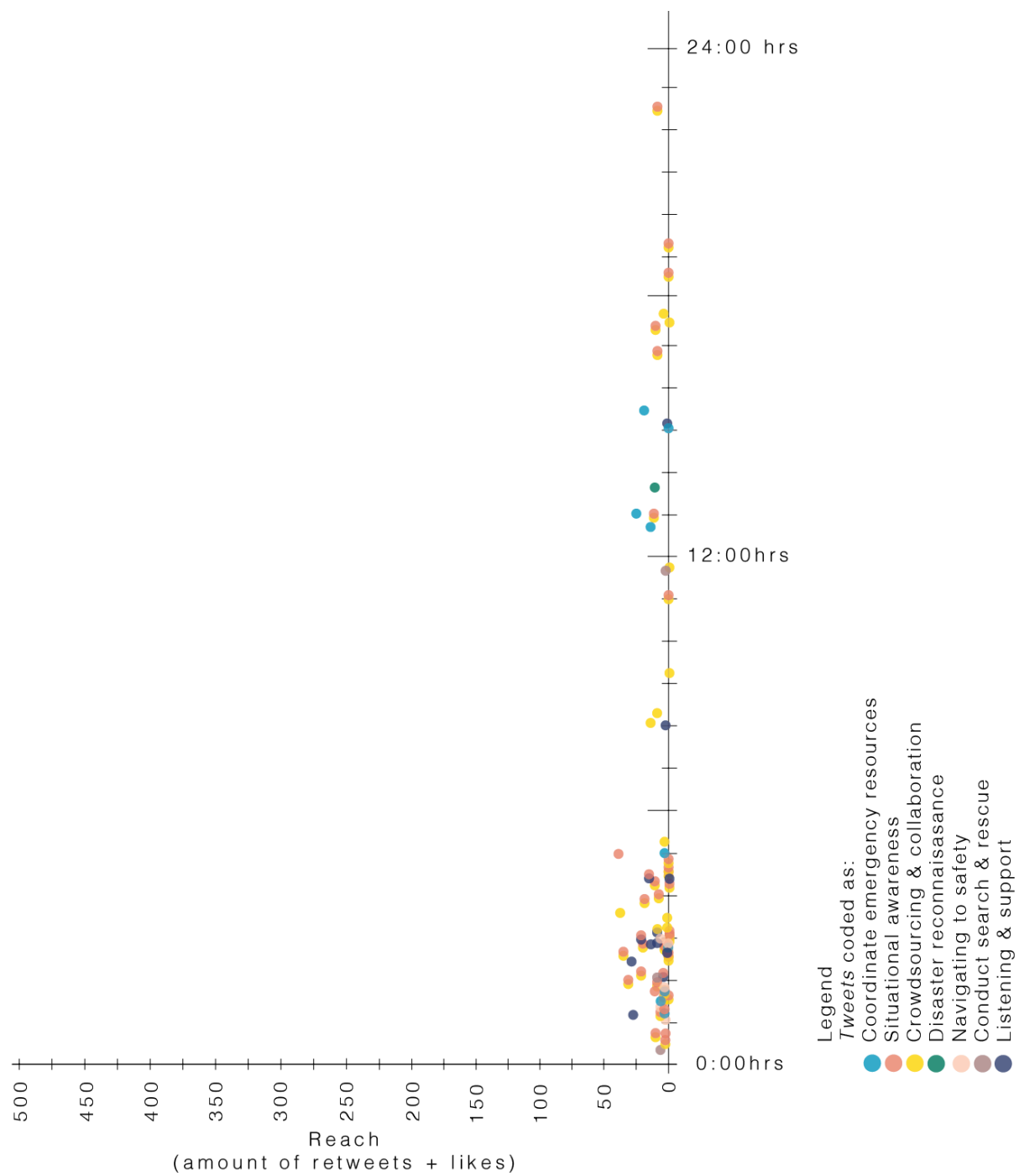


Figure 11. *Tweets* according to their codification that refer to another user

Based on figure 11, which includes *tweets* that refer another user using @, I observed that there is sparse *tweeting*, with distinctive gaps with no *tweets*. *Tweets* coded as “situational awareness” and “crowdsourcing and collaboration” have a similar distribution as the ones in figure 10. There is distinct shift regarding *tweets* coded as “listening and support” focusing mainly in the first five hours, and the ones coded as “coordination of emergency resources” that focus mainly between hours 12 and 16.

The comparison of both figures suggests that the use of @ relates to a more efficient use of Twitter’s capacities. Figure 11 clearly shows the predominance of certain codes during specific hours, unlike figure 10, which only shows constant but unorganized *tweeting*.

While situational awareness and crowdsourcing are extremely relevant, they are already widely present in *tweets* during disasters. In contrast, *tweets* coded as “disaster reconnaissance”, “navigating to safety”, and “conduct search and rescue”, that relate to practical aspects of disaster response, have a notoriously weaker presence along the timeline. This exposes a current gap that can affect the use of Twitter for CBDRR. That gap could be addressed partly by ensuring timely engagement in social media from the actors involved in disaster response.

Table 4. Summary of the amount of *tweets* containing #tierraamarilla

Condition	Nº of <i>tweets</i>	Reach (<i>retweets</i> +likes)
No reference to another user	136	1671
Refer to another user (@)	85	754
Total	221	2425

Additionally, when comparing the amount of *tweets* with no reference to another user with the ones that do, I observed that @ is used in less than 50% of the *tweets* (Table 4). This affects the efficiency of the use of Twitter, since not only the information disseminated is relevant, but also the recipient of that information.

Twitter also has a geo-tag function, allowing placement of tweets in a certain geographical area. It was observed, though, that the actual use of this tool was irrelevant (Figure 12). Nevertheless, when analyzing the most used words in *tweets*, it is observed that the majority refers to a location (Table 5). This results in a less efficient use of the platform, because an important part of the 140 characters available per *tweet* are destined to describe a location, instead of being used to disseminate other important information. I support this observation by referring to Table 5, which is a comparison of

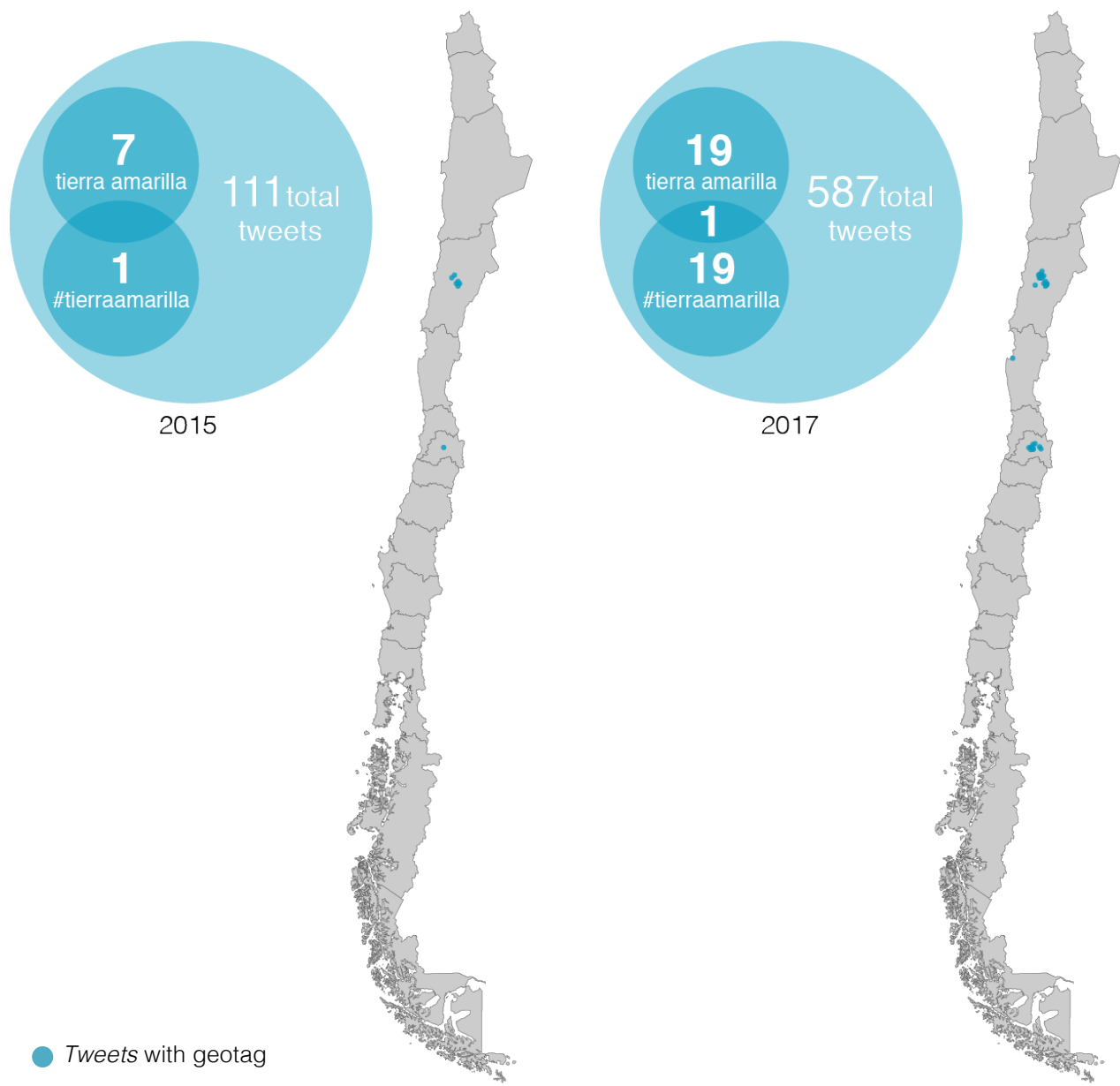


Figure 12. Geo-tagged *tweets* and their location in Chile

the most used words within the retrieved tweets and the category they belong to: event (flood), location (of the event), time, place, actor, and action. Even though some of the most used words varied between both 2015 and 2017, the trend remained, and most of the most used words in both cases relate to a location. The use of the geo-tag option could also add to some of the existing less explored uses of Twitter, such as search and rescue, for example, facilitating the location of the victims.

Table 5. Comparison of most used words in 2015 and 2017

2015					2017			
Word	Nº	%	Category	Word	Nº	%	Category	
1 tierra	100	13%	location	tierra	376	11%	location	
2 amarilla	100	13%	location	amarilla	374	11%	location	
3 copiado	41	5%	location	tierraamarilla	227	6%	location	
4 río	32	4%	event	copiado	198	6%	location	
5 tierraamarilla	15	2%	location	río	126	4%	event	
6 bajando	13	2%	event	atacama	80	2%	location	
7 atacama	13	2%	location	chañaral	79	2%	location	
8 electrica	9	1%	need	desborde	65	2%	event	
9 @emelat_sos	8	1%	actor	sector	52	1%	location	
10 luz	7	1%	need	paipote	43	1%	location	
11 @radionostalgica	7	1%	actor	ahora	37	1%	time	
12 energia	7	1%	need	agua	34	1%	action	
13 loros	6	1%	location	ayuda	34	1%	action	
14 @gafafi	6	1%	actor	@reddeemergencia	32	1%	actor	
15 clases	5	1%	place	gente	32	1%	passive actor	
16 region	5	1%	location	urgente	32	1%	time	
17 cortados	5	1%	action	chile	25	1%	location	
18 municipalidad	5	1%	actor	fuerza	24	1%	action	
19 sector	5	1%	location	@radionostalgica	24	1%	actor	
20 viene	5	1%	action	comuna	24	1%	location	

Overall, engagement in social media, namely Twitter, measured by the reach of *tweets* and the use of @, improves the connectivity into a certain social network. Not only the use of @ generates more connections, which in turn makes the network more complex, but also ensures a wider spread of information within that network. A more complex social network could potentially be more adaptable to changes over time. In addition, by improving the use of @, users could engage with more powerful actors and institutions, like politicians. This could promote empowerment for individuals, potentially give them access to resources, and even facilitate accountability from those politicians, serving as a tool for processes that go beyond CBDRR.

“Through networking with other social groups and through forming broad-based coalitions, the organized poor can have a voice and can influence local government, holding it accountable for efforts geared towards reducing susceptibility to hazardous events” (Delica-Willinson et al., 2004, p.155).

5. Discussion and conclusions

The results fall into the proposed theoretical framework, and support the connection between social media use and vulnerability reduction. The main findings are:

- The effective use of social media during disasters.
- The use of social media has contributed to reduce user's vulnerability. E.g. Twitter was used both in 2015 and 2017 to disseminate warnings, so people could be physically less exposed to the flood.
- The evolution in social media use. E.g. During the 2017 flood, there was more active engagement in Twitter than in the 2015 flood. Also people improved their use of Twitter, by not just *tweeting*, but also engaging with other users and other tools of the platform.

The use of social media for vulnerability reduction requires a broader understanding of the progression of vulnerability, including the characteristics of a certain community and how they perceive risk. Blaikie et al. (2014) introduced the pressure and release model (PAR), emphasizing that there is not only one cause of vulnerability, but a combination of root causes, dynamic pressures, and unsafe conditions. Those root causes “are an interrelated set of widespread and general processes within a society and the world economy” (Blaikie et al., 2014, p.52), being so embedded in that society that they become invisible. In contrast, unsafe conditions are the most visible and specific cause of vulnerability. This theory engages with social, economical, and political systems, but it doesn’t explore the scale of the individual and human agency. In order to complement it, I engage with Engel’s (2016) theory, which argues that vulnerability is defined in terms of exposure, capacity, and resilience. This theory provides more specific insight into the definition of vulnerability, by focusing on individuals over the system, and recognizing their capacities.

Drawing on Engel’s theory, I argue that exposure, capacity, and resilience work in combination, and therefore any variable that influences one of them influences the rest. Using that as a starting point, I explored both adaptation strategies and the dynamics of exclusion that influence vulnerability, by means of a *netnographic* research of the case study. By doing so, I could uncover some of the main features of social media use, and turn it into an opportunity for vulnerability reduction. These features are namely communications, community, network connectivity, and trust, which relate to the different forms of social capital. In particular, two of those forms, bridging and linking social capital, could contribute to decrease vulnerability (Cai, 2017) by establishing new connections outside ones group, thus strengthening their support network, and improving their access to resources.

Both Ellison et al. (2007) and Haythornthwaite (2005) recognize the importance of social media use to establish weak ties, contributing to a latent connectivity that becomes active during disasters. On Twitter, I operationalized latent connectivity as one user following another. That way, both the follower and the followed, who might be part of a

different group, can actively engage with the other and establish communications during disasters. This potentially large and diffuse network of relationships could be used to draw new resources (Ellison et al., 2007)

Together with the vulnerability theories of Blaikie et al. (2014) and Engel (2016), I introduced disaster risk reduction (DRR) as used by Dufty (2016) in order to relate the theory to specific social media applications. DRR defines a process conformed by partially overlapping stages centered on a disaster, instead of focusing on what causes it. This contrasts with PAR (Blaikie et al., 2014), which presents the disaster as the materialization of much broader and complex processes. While I see the practicality of DRR for the *netnographic* research, and to link the use of social media to a community-based approach, I disagree with the generalization of this model that emphasizes the variable of time but neglects others.

Delving into the PAR model and its root causes, Blaikie et al. (2014) reflect on how to deal with them by providing pressure from below to authorities. In addition, Delica-Willinson et al. (2004) refers to networking and organization as fundamental tools to exert that pressure, and have some kind of influence on the government. This connects to the use of social media for linking social capital and empowerment, by providing citizens/users with tools to connect and demand accountability from authorities. Even though I observed potential links to powerful actors, such as private users actively communicating with politicians and governmental institutions, I also noticed the absence of some of the key actors during the flood, namely the local and the central government, and the main mining companies. This is telling about the dynamics of exclusion taking place, but it could pose an obstacle when trying to connect different power spheres, especially if they are not willing to engage. Nevertheless, social media has the ability to make existing societal issues more visible, and to facilitate the creation of a larger, complex, and more adaptable social network. This could prompt the engagement of those powerful actors.

In addition to the empowerment of citizens/users, social media could also contribute to establish stronger and more meaningful connections within a community, which in turn

allows for the increase of social cohesion. E.g. crowdsourcing within social media allows not only for community-based action, with the active participation of users, but also for the self-regulation of the information transmitted through this social network. As explored previously in Chapter 3.2, on Social Media for Social Capital, social cohesion, empowerment, and crowdsourcing, have a direct influence in the building of social capital through bridging and linking strategies. E.g. active engagement on Twitter through *retweets* and likes, considered a strategy for bridging social capital, can contribute to establish new connections, facilitating social cohesion.

Furthermore, social capital can have a positive influence in exposure, capacities and resilience. The participatory widespread nature of social media, and the complex social networks it facilitates, contributes to the decrease of social exposure, by being inclusive and fostering a sense of belonging to a certain online social network. In addition, the timely information shared via social media, could contribute to effectively decrease physical exposure in case of disaster, by giving effective warning, as it did during the 2017 Copiapó River valley floods. Moreover, social media provides the possibility to connect to power structures, and potentially to access resources that can help individuals cope with disasters, adapt to them and overall increase their resilience when facing them. In turn, this helps to impact on some of the root causes of vulnerability, namely inequality.

In Chapter 2.1, on Root causes, I explored the connection between inequality and neoliberalism, and later on in Chapter 2.3, on Unsafe conditions, I explore the concept of individualism as a result of that. Drawing on that, I propose that individualism can be used as a starting point to take action against vulnerability and ultimately, against disaster risk. Social media thrives in an individualistic society, as it shows the extensive use of social media in Chile. So, to use social media to build social capital and empowerment could have an immense impact on the decrease of the vulnerability of Chilean society. This, in turn, could challenge certain features of the neoliberal system, such as the predominance of the idea of individuals over a community.

Another aspect of social media use is that it's influenced by individuals' perception of risk, shaped by their own experience and background. E.g. a member of the local water

board that I interviewed lived outside the hazard prone area. During the 2015 flood, his main concern was to get updates about the water level of the reservoir upstream, in case there was a risk of over flooding. Because of his low exposure to risk, high awareness towards floods, and expert knowledge, his use of social media focused mainly on disseminating trustworthy available information regarding the state of watercourses. Other interviewees in more vulnerable positions had different social media uses. In addition, special attention needs to be addressed to the accuracy and truthfulness of the information created by the users, that could either promote or hinder their situational awareness (Silver, 2016).

I propose to capitalize on social media participative capacities, by using empowerment and crowdsourcing for community based disaster risk reduction (CBDRR). In this context, crowdsourcing not only serves as a verification process for online information (Mehta et al., 2017), but also contributes to CBDRR by allowing individuals to actively participate and strengthen the community in the context of a disaster. An important observation drawn from the *netnographic* research is the limited engagement on social media of actors involved in practical aspects of disaster response, during the first hours of the disaster. The higher their participation on social media during disasters, the more reliable information there is available to regular users. This could improve the usefulness of a community-based approach, by combining knowledge coming from both regular users and key actors. In addition, it could be even more beneficial if all these actors would use most of the social media platform's capacities. For the case of Twitter, this could entail geo-location, the use of @, and the use of # regarding a specific topic or event. Overall, specific changes in social media use, could improve CBDRR.

It is relevant to stress that social media is mainly a tool and it is not intended to work in isolation, but together with suitable policies, engaged citizens, and appropriate management. In addition, access to social media, although popular, doesn't necessarily reach all the population affected by a disaster. Issues such as connectivity due to a generational gap, a lack of trust or resources, or the overcrowding of the network can affect the effectiveness of this tool. This becomes an important aspect to take into

account, since the percentage of social media users per country can be crucial to the failure or success of social media as a tool for CBDRR. Nevertheless, social media use in Chile is so high (71% according to We are social & Hootsuite, 2017), that I expect it is not a limitation for this case.

The discussion drawn from this exploratory work about the links between social media and vulnerability in disasters is based both on theoretical and empirical research, with results that support those theories. The reduction of vulnerability through the use of social media is explored through two vulnerability theories (Blaikie et al., 2014; Engel, 2016) that complement each other by engaging with different aspects, and scales. They also recognize its dynamism and the influence of both global processes and human agency.

Additionally, the *netnographic* research empirically unveils certain situations and relations, while the interviews contribute to get a deeper insight about a specific discovery. The main contribution of *netnography* in this case is the insight it provided about the evolution of vulnerability between 2015 and 2017, observed mainly through adaptation strategies and its implications. By using this method, I recognize and emphasize the dynamism of vulnerability overtime. “Across academic fields, *netnography* has been found immensely useful to reveal interaction styles, personal narratives [...], discursive styles, innovative forms of collaboration and organization, and manifestations of creativity” (Kozinets, 2010, p.3) *Netnography* contributes to ethnographic studies by giving access to new content, allowing for ethnographic research of past events, and by the promptness to access data. It can have certain limitations, explored in 1.2.1 on Data collection and analyze methods. Those limitations could change according to the social media platform, but overall, *netnography* surpasses traditional ethnographic methods in terms of access to data (type, amount, promptness, and access to historical data).

In conclusion, social media has changed how people communicate during disasters, providing a new channel for more direct and effective communication. The main finding of this thesis is that vulnerability could be reduced through the use of social media by helping to deal with the factors that cause vulnerability, influencing the exposure,

capacity and resilience of individuals, and playing a role in community-based disaster risk reduction.

I propose this work could serve as a starting point for more in-depth studies regarding the connection between social media use and vulnerability. Such exploration could shed some light into the specific influence of social media on vulnerability reduction.

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