GLOBAL EARTHQUAKE MODEL
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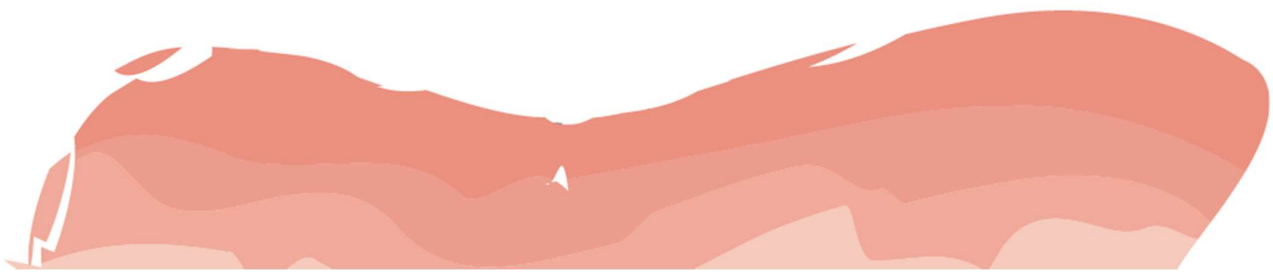
Report on the workshop for the participatory evaluation of earthquake risk and resilience in Quito, Ecuador

Report produced in the context of the GEM South America Integrated Risk Assessment (SARA) Project

Version 1.1 – December 2015



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The GEM-SARA workshop for the participatory evaluation of earthquake risk and resilience in Quito, Ecuador was carried out during the 23rd and 24th of July 2015. The following participants attended the event:

Community participants

Ing. Jorge Ordoñez
Tnlgo. Mario Mosquera
Ing. Franklin Aguirre
Sr. Santiago Carpio
Sra. Grace Jácome
Ing. Kelly Mite
Ing. Aracelly llumigusin
Ing. Juan Carlos Singaucho
Ing. Matthieu Perrault
Cristina del Pozo
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Ma Augusta Cusquillo
Franklin Cabrera
Henry Medrano
Luis Montes
Fausto Pillajo
Jorge Enrique Dominguez
Luis Quilumba
Maria Augustina Simbaña
Daniel Lascano
Leonardo Simba

Representatives of public institutions

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Marina Maldonado
Braulio Aguirre
Caroline Flores
Jimena Riofrío
Bolívar Calero
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Juan Reina
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Sofia Mejía
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Jimena Bastidas
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The views and interpretations in this document are those of the individual author(s) and should not be attributed to the GEM Foundation. With them also lies the responsibility for the scientific and technical data presented. The authors do not guarantee that the information in this report is completely accurate.

Citation: Valcárcel, J.A., Burton, C.B., Villacis, C. (2015) "Report on the workshop for the participatory evaluation of earthquake risk and resilience in Quito, Ecuador", V1.0, 17/10/2015, South America integrated Risk Assessment, available from http://www.nexus.globalquakemodel.org/[url-of-groupspace-on-GEM-Nexus]

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TABLE OF CONTENTS

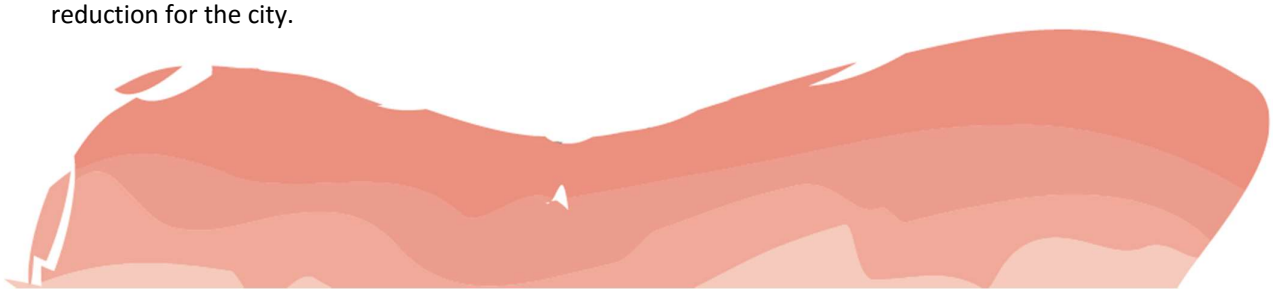
SUMMARY

The South America Risk Assessment (SARA) project promotes the evaluation of earthquake risk from an integrated perspective. This integrated perspective not only accounts for the estimation of human and economic losses from damaging earthquake events, it includes measuring characteristics within communities that affect the distribution of impacts and a community's ability to recover. This integrated perspective is accomplished, in part, through the development of indicators and indices of social vulnerability (characteristics within social systems that create the potential for loss) and the combination of these with estimates of physical risk (i.e. human or economic losses). Indicators and indices are increasingly being recognized as useful tools for policy development in the area of natural hazards risk because they can summarize complex and multidimensional realities. Their use, however, for earthquake risk reduction policies may invite overly simplistic results. This especially applies to circumstances where characteristics of populations at risk are highly multidimensional and place specific, making them difficult to measure.

To address these caveats, the Global Earthquake Model (GEM), the Center for Disaster Management and Risk Reduction Technology (CEDIM), and the South Asia Institute (SAI) collaborated to develop the Resilience Performance Scorecard (RPS). The RPS is a multilevel and multi-scale self-evaluation tool that empowers stakeholders to assess earthquake risk and resilience parameters based on qualitatively derived information using innovative data collection technologies. It is within this context that six dimensions are evaluated to address key areas of resilience that mainstream risk reduction into planning and decision-making processes: social capacity, awareness and advocacy, legal and institutional, planning and regulation, critical infrastructure and services, and emergency preparedness and response.

The RPS was adjusted to the context of a South American city and administered for the Quito Metropolitan area in a workshop sponsored by the Metropolitan Directorate of Risk Management in Quito that spanned two days (July 23 – 24). The workshop was held with two different groups of participants: 1) Parroquia representatives from Quito and 2) municipal representatives from different departments concerned with Disaster Risk Reduction and Management within the city. Each group conducted the survey with the help of a local facilitator. The facilitator ensured that all questions were adequately understood, misinterpretation was minimized, and discussions were steered and targeted.

The application of the RPS was useful in order to evaluate the status, current gaps, and achievements with respect to key dimensions of resilience in Quito. Using the results reported within, it might be possible for relevant stakeholders to discover areas of opportunity in which further efforts are needed to evaluate the resilience of systems within their city, to update resilience enhancement strategies with the participation of public institutions and community leaders, to set benchmarks for resilience enhancement over time, to foster communications between various levels of government, and to develop earthquake risk reduction strategies. A set of potential activities for increasing resilience have been suggested in this report, in order to contribute to the development of a long term earthquake plan reduction for the city.



1 PARTICIPATORY EVALUATION OF EARTHQUAKE RISK AND RESILIENCE IN QUITO

To better understand the earthquake risk for a city such as Quito in its entirety, there is a need to move beyond earthquake hazard and damage assessments. For a more complete view of a city's risk, it is essential to understand characteristics within societies that create the potential for loss and harm as well as characteristics that affect the ability of populations to prepare for and recover from damaging earthquake events. These characteristics can be combined with analyses of hazard and expected losses to achieve an integrated and holistic understanding of the risk, impact, and recovery potential of a given (urban) area.

The main purpose of this workshop was to introduce participants to a tool and framework that was designed for use by local decision-makers to address the differential susceptibility of populations to adverse impacts of earthquake events in a holistic manner. Participants used state-of-the-art data collection and communication technologies to identify and discuss gaps in the resilience within their communities along six dimensions that mainstream disaster risk reduction into planning and decision-making processes:

- Awareness and advocacy
- Social capacity
- Legal and institutional arrangements
- Planning, regulation and risk mitigation
- Emergency preparedness, response and recovery
- Critical services and public infrastructure resiliency

1.1 Objectives

Resilience is defined in numerous ways depending on the context to which it is applied and the disciplinary background of those interested in the topic. Resilience is defined for this report as the ccapacity of individuals, communities, organizations, cities, and nations to respond, cope and recover from disaster (UNISDR 2009). The resilience of cities is not confined to infrastructure systems alone, but also encompasses characteristics of cities such as the social capacities of populations, pre-existing economic circumstances, and the capacity of institutions, both public and private, to reduce risk. While the term 'resilience' is often described as an umbrella concept in order to describe a community's ability to resist, absorb, and recover from disasters, it is necessary to apply the concept to different sectors of local government, and at multiple scales of analysis.

To capture local processes for decision-making and to produce relevant indicators of resilience for communities, different types of indicators that are representative of the local conditions and context are needed. These types of indicators cannot be computed from publicly available databases (such as those from national censuses) and require the design of targeted surveys. It is within this context that scorecards such as the Resilience Performance Scorecard (RPS) have become popular tools for measuring resilience using stakeholder input.

The purpose of the RPS is to provide a tool that can capture the key functional and organizational areas for urban resilience with local government officials as the targeted decision-making body. The implementation of the Scorecard in Quito required engagement with stakeholders for the design of the

indicators (questions) and targets (answer schemes) of the Scorecard. It was anticipated that the Scorecard approach would provide a "broad brush" assessment to enable local policy makers and communities to establish priorities for more in-depth analysis, to allocate funds, and to develop emergency and disaster management programs more effectively.

The specific objectives of this workshop were to utilize the Resilience Performance Scorecard to offer community leaders and city officials in Quito a means to:

- better understand and identify key gaps in earthquake resilience at the community and institutional level within their city;
- facilitate discussion between community leaders, stakeholders, and officials regarding their seismic risk and resilience;
- work with emergency services and other agencies on earthquake risk reduction;
- create an agenda to foster the development of detailed risk and resilience assessments based on the identified gaps that could lead to the construction or update of resilience management strategies;
- create benchmarks for monitoring and evaluating resilience and earthquake risk reduction; and
- take collective responsibility to reduce the impacts of damaging earthquake events

The remainder of this report is organized as follows. Sub-section 1.2 presents the study area and its exposure to earthquake events. Section 2 provides the methodology used for the analysis of resilience. Section 3 delineates the results obtained for each question using the scorecard approach. Section 4 presents an analysis of the results by dimensional driver of resilience, and Section 5 presents activities and projects that could be of interest in order to improve the earthquake resilience of Quito.

1.2 The Metropolitan District of Quito

Quito is the capital district of Ecuador. Quito is located in the province of Pichincha, at the north of the country, in the Andean Cordillera (see Figure 1). According to the National Institute of Statistics (INEC)[1] the population of Quito in 2015 was approximately 2,551,721 inhabitants. Table 1 presents vulnerable groups as a percentage of the total population. From this table it is possible to observe that the percentage of the working age population (between 18 and 65 years) is relatively high (around 58.9%) and the unemployment rate is low (near 3.6%). Nevertheless, more than a third part of the population (36.4%) is below the poverty line (SHTV 2013).

[1] See http://www.ecuadorencifras.gob.ec/proyecciones-poblacionales/ [Last checked 19/10/2015].

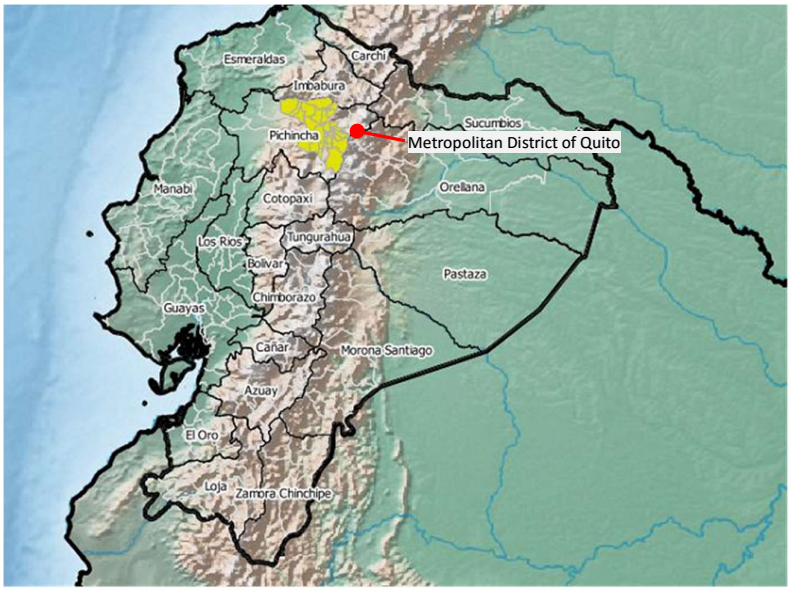


Figure 1 Map of Ecuador and location of the Metropolitan District of Quito

Table 1 Vulnerable groups as percentage of the total population

Vulnerable groups	Percentage of the total population
Population under poverty line	36.34%
Population under 18 years	34.8%
Elderly	6.3%
Unemployment	3.6%
Ethnical groups	7.2%
Single mothers	3.5%

The Metropolitan District of Quito is divided in Administrative Units and neighborhood sectors (see Figure 2). The total area is 423,050.5 ha, and the urban area corresponds to 52,479 ha, consisting of an urban population density of 42.7 inhabitants per ha. Between 1990 and 2001, the annual population growth rate was 2.6%; between 2001 and 2010 this rate was 2.2% (SHTV 2013). The estimated contribution of the city to the Gross National Production is around 15% (La Hora 2011).

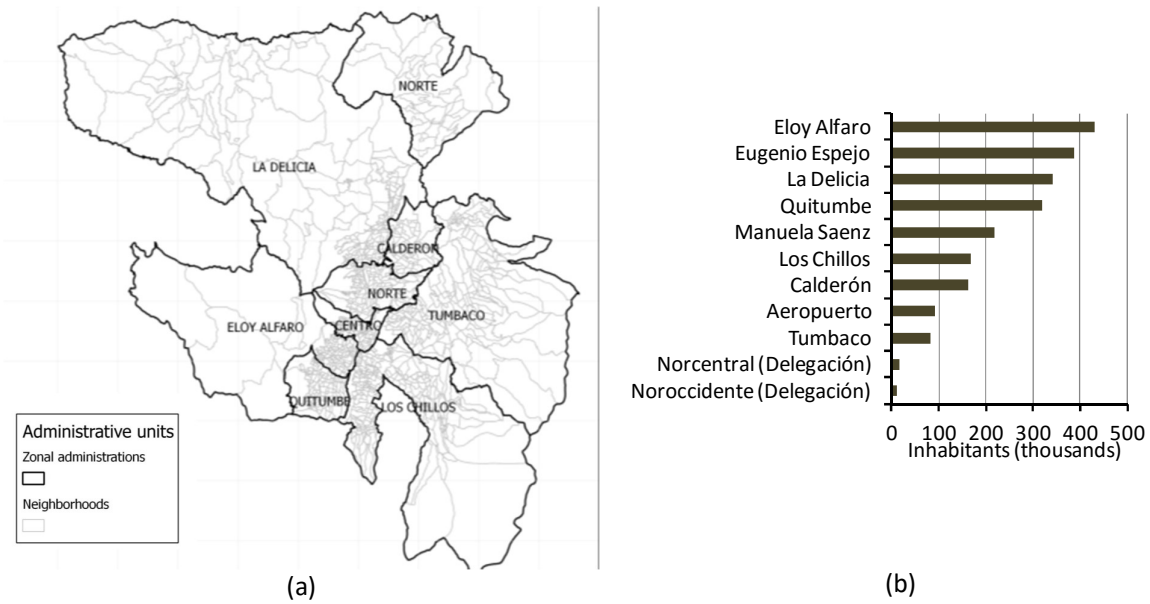


Figure 2 (a) Administrative units of the Metropolitan District of Quito; (b) Population by administrative units

1.2.1 Seismic risk of Quito

The level of seismic activity in Ecuador is considered high. Figure 3 presents the unified earthquake catalogue developed by Beauval et al. (2013). From this Figure it is possible to observe that seismic events of considerable magnitudes have occurred near to Quito; between 1541 and 1999, 23 events were felt in Quito with an intensity of VI or bigger. The most recent events are the earthquakes of 1987(Ms 6.9) and 1990 (Ms 4.9), located at 80 km and 10 km respectively, which caused structural and non-structural losses (Yépez 2002). In addition, this city has experienced damaging earthquakes occurring not only in the immediate vicinity, but also with epicenters far away. For instance, a 1797 earthquake that occurred about 150 km to the south of Quito (Chatelain et al. 1999) caused damage to the city.

Figure 4 shows the seismic hazard map of Ecuador adopted for the national building code (NEC-11 2011). From this map it is possible to observe that, for a return period of 475 years, the Peak Ground Acceleration (PGA) expected in Quito is around 0.4 g, representing a high seismic demand for buildings and infrastructure. It is worth mentioning that the seismic hazard model was developed using the OpenQuake Engine, provided by the Global Earthquake Model (GEM) Initiative.

The city has grown significantly in the last 30 years. In 1990, the total population was estimated in 1,388,500 inhabitants; meanwhile in 2010 it was estimated at 2,239,191. This rapid expansion of the city resulted in an increase in urban density and to the construction of non-engineered buildings that are located in hazardous areas such as steep mountain slopes (Chatelain et al 1999). This environment has promoted the development of studies of the seismic risk of the MDQ.

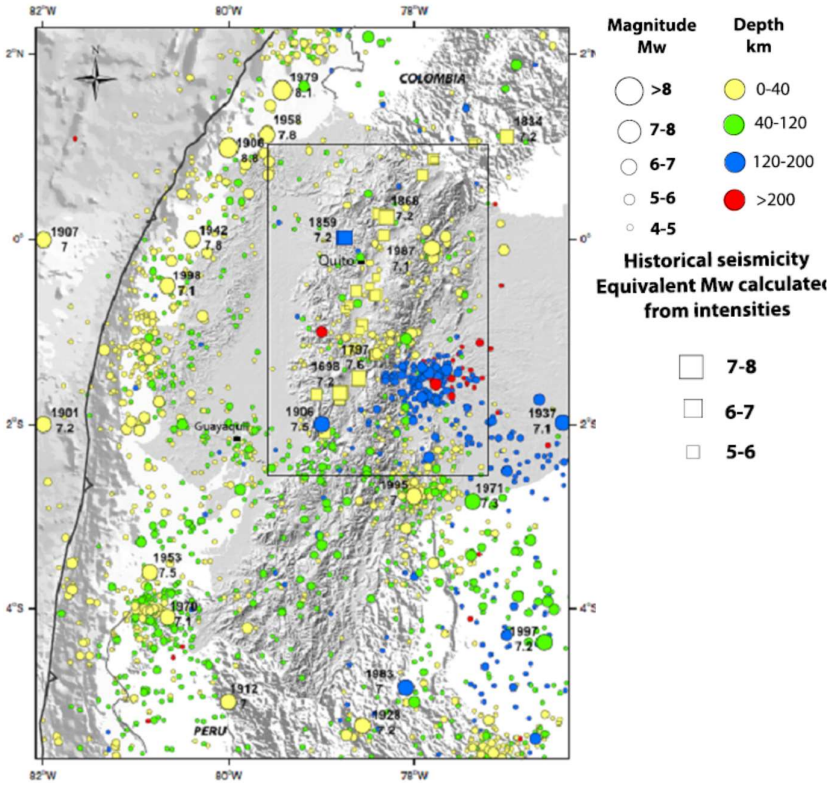
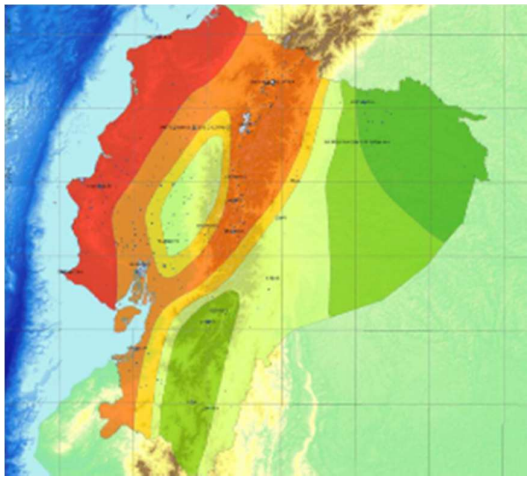


Figure 3 a) Unified earthquake catalog 1587–2009

Source: Beauval et al. (2013)



Peak Ground acceleration (g)	
	0.15
	0.25
	0.3
	0.35
	0.4
	>0.5

Figure 4 Seismic hazard map of Ecuador, Tr 475 years

Source Norma Ecuatoriana de la Construcción-NEC 2011

Nowadays, the GEM Foundation, with funding from Swiss Re Foundation, has been promoting the development of tools and methodologies in order to estimate the seismic risk at various levels in South America through the project: South America integrated Risk Assessment (SARA). At the city level, seismic scenarios are to be developed in Quito in order to update damage calculations for residential buildings, taking into account recent national seismic hazard models and microzonation studies.

2 METHODOLOGY

2.1 City resilience assessment

To develop plans to enhance the resilience of communities, the first step is to objectively measure resilience. Measurement is vital not only to evaluate and benchmark the baseline conditions of what makes communities resilient, but also to help communities to understand the factors that lead to damaging impacts and differential capacities to respond to events. Composite indicators (also referred to as indices) are often employed as useful tools to evaluate resilience because they convey information that may be utilized as performance measures to guide decision-making. Generally speaking, an indicator is a quantitative or qualitative measure derived from observed facts that simplify and communicate the reality of a complex situation. A composite indicator is the combination of individual indicators that represent different dimensions of a concept that cannot be fully captured by any individual indicator alone.

Although indicators are recognized as useful tools at the policy level, they are subject to a number of criticisms. First, indicators may send misleading messages if they are poorly constructed or misinterpreted, especially in areas where data availability is a concern. In addition, indicators may invite overly simplistic conclusions regarding areas of opportunity to enhance the resilience of communities. Indicators may also lead to inappropriate conclusions if dimensions of resilience that are difficult to measure are ignored. Such dimensions include the amount of social networking within and between communities, cultural attributes and decision-making.

To capture local processes for the development of relevant indicators and for targets for producing actionable information to increase resilience, the compilation of different types of indicators that are representative of the local knowledge and context was needed. The implementation of the Scorecard in Quito required engagement into a preparatory process where the local context was captured into the design of the indicators and answer schemes of the Scorecard.

2.2 Resilience dimensions

Following the strategic goals of the Hyogo Framework for Action, as well as the UNISDR 10 Essentials of a Resilient City[2], the Resilience Performance Scorecard was developed to address community resilience in key dimensions within a City government's functional and operational activities. The following six dimensions where mainstreaming of risk reduction into planning and decision-making processes take place at the local level have been identified:

1. Awareness and Advocacy: represents the level of awareness and knowledge of earthquake risk in community leaders and public institutions.

[2] See: http://www.unisdr.org/campaign/resilientcities/toolkit/essentials [Last checked 19/10/2015].

2. Social Capacity: related with the capacities of the population to efficiently prepare, respond and recover from a damaging earthquake.

3. Legal and institutional arrangements: corresponds to the mechanisms available to advocate earthquake risk reduction in the city

4. Planning, regulation and mainstreaming risk mitigation: related with the commitment and mainstreaming of disaster risk reduction through regulatory planning tools in the city

5. Emergency preparedness, response and recovery: reflects the effectiveness and performance of the risk management system for response and recovery in case of emergencies

6. Critical services and public infrastructure resilience: corresponds to the capacity of lifelines and critical facilities to react and respond during and after earthquake events.

The Scorecard was developed to address key issues of urban resilience at multiple levels of geography. While the key dimensions of the Scorecard are consistent across different scales, the indicators (questions) and targets (answer schemes) along each of the themes within the six dimensions were adjusted to represent the appropriate scale (see Figure 5).

For example, enforcement and implementation of building codes is a function at the municipal and not the sub-municipal (i.e Parroquia) level. To ensure relevancy to the local context, targets (answer scheme) and indicators (scorecard questions) for measuring urban resilience in Quito (for each of the six key areas) are based on in-depth interviews with various stakeholders such as academia, urban planners and urban planning associations, community development associations, city and local officials, national and international NGOs and relief and response organizations.

Figure 5 Themes and levels of geography

The six key areas of the Scorecard are closely aligned with the elements of the HFA (see Figure 6). The urban resilience goals are divided into three strategic goals shown in the chart. Each of the strategic goals corresponds to one or more key dimensions analyzed in the Scorecard where these goals are to be implemented. The rationale for selecting these six dimensions can be traced to the 10 essentials.

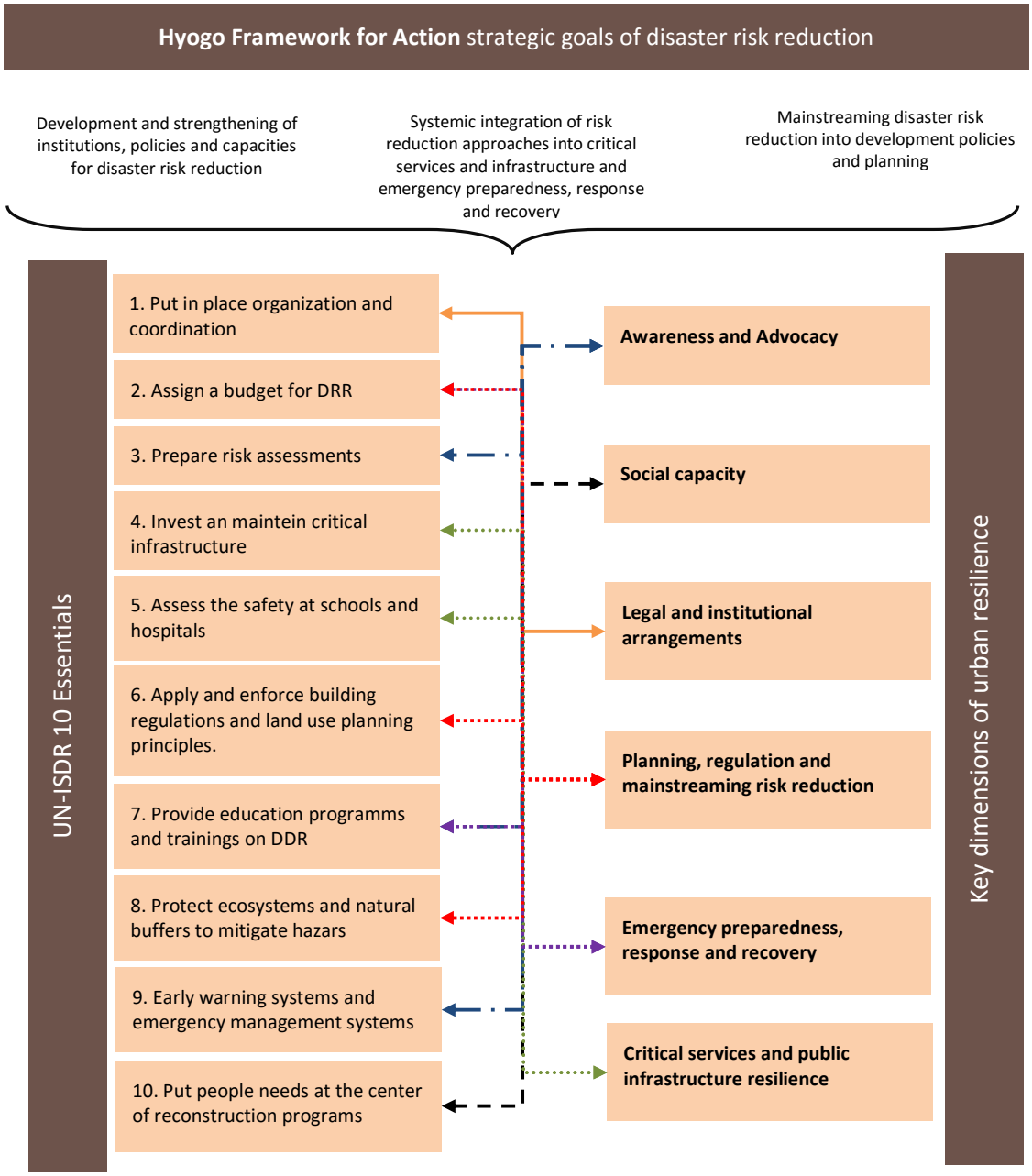


Figure 6 Relation between HFA strategic goals, 10 essential and key dimensions for urban resilience

2.3 Structure of the Scorecard

The purpose for the development and application of the Scorecard approach is to promote a tool that can capture the key functional and organizational areas for urban resilience with local government officials as the targeted decision-making body. In this regard, the structure of the Scorecard was developed considering the dimensions listed above. In addition, each dimension was divided into a set of indicators (questions). Table 2 lists the indicators considered for each dimension and their rationale.

Table 2 Rationale of the indices adopted for resilience assessment

Indicators	Rationale
Dimension: awareness and advocacy	
Level of awareness and knowledge of earthquake risk	Informed and concerned population about potential impacts of disasters will demand the development of risk mitigation projects and will participate in emergency response activities.
Information about earthquake safety, preparedness, and risk reduction.	Adequate channels and mechanisms of communication facilitate the dissemination of relevant information for risk identification, mitigation and emergency response.
Public outreach activities informing about disaster safety, preparedness and risk reduction	Meetings, presentations and events regarding earthquake risk allows stakeholders to disseminate relevant information for vulnerability reduction and emergency response. Also, such meetings are useful to raise awareness and create community groups working for their seismic safety.
Trainings and capacity building programs to increase technical and professional resources for earthquake risk reduction	Trained persons will demand and lead the development of risk mitigation activities within their communities.
Dimension: social capacity*	
Healthcare and social assistance programs available for vulnerable groups	Healthcare providers, including physicians, nursing homes, and hospitals, are important post-event sources of relief. The lack of proximate medical services will lengthen immediate relief and longer-term recovery from disasters
Ties and connections between people	A community with strong ties is more likely to create organizations and working- groups for risk reduction and emergency response.
Social integration considering different economic levels	The socioeconomic status of communities determines the ability to absorb losses and enhance resilience from hazard impacts. Wealth enables communities to absorb and recover from losses more quickly due to insurance, social safety nets, and entitlement programs. Those people who are totally dependent on social services for survival are already economically and socially marginalized and require additional support in the post-disaster period
Social integration of minority populations	Race and ethnicity imposes language and cultural barriers that affect access to post-disaster funding and residential locations in high hazard areas.
Access to electricity gas and clean water	The lack of access to sewers, bridges, water, communications, and transportation infrastructure represents a condition of vulnerability and marginalization. A community fully equipped with public services and lifelines will respond better in post-earthquake situations.
Primary education	Education is linked to socioeconomic status, with higher educational attainment resulting in greater lifetime earnings. Lower education constrains the ability to understand warning information and access to recovery information.
Interaction between formal and informal institutions	Strong interactions between formal (governmental) and informal institutions facilitates the development of risk mitigation projects and emergency response plans.
Participation in decision making	Formal mechanisms of participation of community leaders in decision making allows the incorporation of community needs in programs for disaster risk management.
Protection of historic buildings and cultural heritage	The protection of cultural values and heritage is a key aspect in order to preserve the identity of communities.

** Adopted from Cutter et al. (2003)*

Table 2 Rationale of the indices adopted for resilience assessment (Continuation)

Indices	Rationale
Dimension: legal and institutional arrangements	
Regulations, ordinances, or incentives for earthquake safety and risk reduction	Legal instruments such as regulations and ordinances usually establish responsibilities, duties, plans, concepts, strategies and priorities. Therefore, such instruments facilitate the coordination between public institutions, communities and the private sector regarding the development of risk mitigation projects and emergency response activities.
Community leaders with roles and responsibilities for Disaster Risk Reduction	Formal mechanisms of participation of community leaders in decision making allows the incorporation of community needs in programs for disaster risk management.
Mechanisms of coordination and cooperation for disaster preparedness, safety and risk reduction	
Confidence in the central and local government and non-governmental institutions to prepare for, respond and recover from a damaging earthquake	Confidence in the government facilitates the use of public resources and the participation of communities in the development of risk management programs.
Dimension: planning, regulation and mainstreaming risk reduction	
Earthquake resistant building construction codes	Building codes and their implementation reduces the construction of structures highly vulnerable to earthquake events.
Reinforcement and retrofitting of private infrastructure	The retrofitting of private infrastructure mitigates the physical vulnerability of (residential, commercial) buildings, reducing potential damages and losses in case of events.
Availability and use of earthquake insurance	The use of insurance regarding earthquake risk favors the availability of economic resources for recovery and reconstruction activities.
Availability of funding for disaster risk management plans or earthquake mitigation programs	The availability of financial resources facilitates the development of risk identification and mitigation programs.
Dimension: emergency preparedness, response and recovery	
Population storing goods to be used in case of disasters	Population storing goods will have access to resources required to guarantee minimal conditions of living in emergency situations. Such population will not depend entirely from the aid and support from the community, the government and public institutions.
Local centers for implementing and coordinating emergency response and management	Centers with adequate resources for emergency coordination facilitates the decision making process during crises, providing a common space for the communication and the interaction between different actors (public, private institutions and communities) as well as the access to essential services for people participating in the management of emergencies.
Standard operational procedures for coordinating emergency rescue and response activities	In case of emergency, protocols and procedures for emergency response are useful in order to define the required participants and resources as well as their roles and responsibilities.
Funds for emergency preparedness, response and recovery operations	The availability of funds for emergency response facilitates a prompt assistance to the affected population, as well as the repair and reconstruction of infrastructure damaged.
Human resources for emergency preparedness, response and recovery operations	The availability of human resources and equipment favors a prompt and effective response in case of emergency.
Equipment for emergency rescue, response, and cleanup operations	
Response plan for post-earthquake emergency operations	Plans for post-earthquake emergency operations are useful in order to define responsibilities and resources required for a prompt and effective response.

Table 2 Rationale of the indices adopted for resilience assessment (Continuation)

Indices	Rationale
Dimension: critical services and public infrastructure resilience	
Assessment, reinforcement, and retrofitting of critical public infrastructure such as schools and hospitals	Facilities such as schools, hospitals, and critical infrastructure such as lifelines provides important services to communities in normal conditions as well as in the case of emergencies. Therefore, the reduction of the structural and non-structural vulnerabilities of such buildings and infrastructure could be promoted in order to guarantee their operation and functionality during and after earthquake events.
Structural improvements to reduce seismic risk in lifelines	
Business continuity plan of local governmental offices for the aftermath of a damaging earthquake	Business continuity plans are useful in order to guarantee the operation and functionality of governmental offices after emergencies and earthquake events.
Plans for the repair or replacement of critical lifelines in the aftermath of a damaging earthquake event	The implementation of plans for recovery and reconstruction of lifelines facilities a prompt restoration of the services affected, by defining responsibilities, functionality targets and financial resources required.

2.4 Scoring system

For each index, a set of targets (answer schemes) was established in order to track progress on the mainstreaming of risk reduction in the city's organizational, functional and operational systems and processes. In this sense, the implementation of the Scorecard required engagement into a preparatory process where the local context was identified for the design of the indicators (questions) and targets (answer schemes) of the Scorecard.

The targets were defined by using four main categories (see Khazai, et al. 2015):

1-Almost none: "Little or no awareness" This level represents little or no awareness and understanding of mainstreaming. There is no institutional policy or process for incorporating risk reduction within the functions and operations of the organization. Further, in some cases there is an adverse attitude and adverse institutional culture towards adopting measures to reduce risk. As a result, significant resistance is expected from any risk reduction initiative resulting in greater vulnerability and higher losses in the future.

2-Low: "Awareness of needs" This level refers to an early stage of awareness. The organization has a growing level of awareness, and there is support for disaster reduction among the policy makers. The institution may have activities and dedicated efforts for preparedness but these are simply limited to response. However, support is limited and does not necessarily carry through all levels of the organization; resistance to change is expected at various levels where business as usual is judged sufficient. In general, the institution has no established policy, guidelines or system for mainstreaming, and action will be needed at the highest level to establish such policies and systems. This level is expected not to result in risk reduction in the long term. Vulnerability is expected to increase.

3-Moderate: "Engagement and Commitment". The third category refers to a high level of engagement and commitment to Disaster Risk Reduction (DDR) by the institutions. However, the policies and systems have not been fully established yet. The institution may not have a deep understanding of the mainstreaming process and requirements and still has limited capacity, but overall it is willing to make the investments and has already taken some action; commitment for change, and in particular to shift

from response only to mainstreaming DRR. There may be "pockets of resistance" but these are expected to be overcome with time.

4-High: "Full integration" This level refers to a situation where risk reduction is fully absorbed into planning and development processes as well as core services. The organization places high importance on reducing disaster risks in a sustainable program of action at multiple levels and within multiple sectors, and there is a comprehensive demonstration of practice. This level describes a situation where disaster risk reduction is "institutionalized". However, this is not to suggest that an optimum level of attainment has occurred: there is still a need for further progress. The process of mainstreaming should be viewed as open-ended: while organizations should aim to achieve this level, they should also aim to make continuous improvements to their approach.

Within these levels, graduated variations of the following topics have been also considered:

- Level of implementation of risk reduction, emergency response and recovery plans
- People participating in disaster risk management programs
- Availability of mechanisms of information, coordination and communication
- Frequency and participants involved in risk management activities
- Coverage of risk management programs, lifelines and critical services
- Availability of resources for risk mitigation, emergency response and recovery

For the sake of simplicity, numerical values (1 to 4) have been assigned to each category. A score for each question (and Parish) has been calculated by using linear max-min normalization and the average results obtained by the correspondent participants as described in Eq. 1.

$$SI_{i,j} = \frac{max - avg}{(max - \min)} \quad \textbf{Eq.1}$$

Where $SI_{i,j}$ is the score of the index *i* and dimension *j; max* corresponds to the maximum score (4), *min* corresponds to the minimum score (1) and *avg* corresponds to the average of the participants' results. Finally, a score for each dimension was obtained as the average of the scores obtained for the correspondent indices. By using such a normalized scale, results close to 0 represent a very low resilience (almost none) and values close to 1 represent a high resilience.

In this way, the aim was to collaboratively develop and implement an initial Scorecard that can guide the city of Quito and other stakeholders in understanding potential gaps in resilience, in which strategies can be put into place to fill those gaps, and research can be applied to critical areas where further analysis is needed.

2.5 Workshop setting and participants

On the 23rd and 24th of July, 2015, a two-day workshop was organized with the participation of two main groups: community leaders and representatives of public institutions with an interest in disaster risk in Quito. The list of institutions and Parishes attending the workshop are listed below:

Institutions	Parishes
Armed Forces Command	Chillogallo
Cadastral Metropolitan Directorate	Chimbacall
Fire Brigade	Choupicruz
Metropolitan Directorate of Risk Management	Cocotog
Metropolitan Institute of Heritage	Comité del Pueblo
Metropolitan Public Company of Potable Water and Sanitation (EPMAPS)	Concepción
National Police- General Directorate of Operations	Conocoto
National Institute of Geological, Metallurgical and Mining Research (INIGEMM)	Cumbaya
National University	Guamaní
Patronato San José	Kennedy
Secretariat of Social Integration of Quito	La Carolina
Secretariat of Land, Habitat and Housing of Quito	La Ecuatoriana
Zonal Administrations:	La Luz
-Calderón	Magdalena
- Centro	Monteserrín
- Eloy Alfaro	Ponceano
- Quitumbe	Quitumbe
- La Delicia	San Carlos
- La Mariscal	San Juan de Amagasí
- Los Chillos	

Public institutions

Community leaders

Figure 7 participants of the workshop

Three sessions were utilized in order to capture the scores of each group independently, and a final session of discussion and comparison of results was conducted. It was anticipated that the Scorecard approach would enable local policy makers and communities to establish priorities for more in depth analysis, to allocate funds, and to develop emergency and disaster management programs more effectively. The use of the scorecard helped to identify the degree to which communities are able to build their resilience because they are able to identify gaps and opportunities for resilience enhancement. The latter allowed communities to: 1) foresee and/or acknowledge threats and risks; 2) work with emergency services and other agencies on earthquake risk reduction; 3) have a sense of community and social capital; and 4) take collective responsibility to reduce the impacts of disruptive events and disasters.

3 EVALUATION OF EARTHQUAKE RESILIENCE IN QUITO

3.1 Risk management in Quito

3.1.1 Background

During the last 15 years, several achievements in risk management have been accomplished in Quito, most of them triggered by different emergencies. A summary is presented in Table 3.

Table 3 Main achievement in risk management in Quito

Period	Main achievement
<1998	No formal risk management programs or systems were available; few hazard and vulnerability studies were promoted by international organizations. Until that moment, only emergencies attention was considered through the firemen of Quito
1999	Given the activity of the volcano Guagua Pichincha the Unit of Risk Management was created
2002	Two prevention and attention plans (Fire Plan and Rain Plan) were created given the emergencies derived from fires and floods
2004	Creation of the Metropolitan Central of Citizen Attention (CMAC) for the reception of emergency calls.
2008	Creation of the Metropolitan System of Risk Management of the Metropolitan District of Quito
2009	Implementation of the Urban Risk Reduction Program of the City.
2011	Creation of the "Sala Situacional de Emergencias" for the centralization of emergency resources of the city
2012	Implementation of the Emergency system Ecu 911

Source: Proaño-Castro (2012)

In particular, through the Metropolitan Ordinance 0265 of 2008 a Metropolitan System of Integrated Risk Management of the Metropolitan District of Quito (MSIRM) and a Unified System of Geographical Information were defined. The main objective of this system is to coordinate and facilitate the interaction between private, public and international institutions in order to work for the safety of the communities and the public infrastructure.

The Agenda of the Citizen Safety of the MDQ includes the following policies: (i) to promote and assume risk management as a transversal axe of urban planning and development of the city; (ii) to generate a prevention culture and the preparation of the population when facing natural and anthropogenic risks; (iii) to protect the community to dangerous events; (iv) to strengthen the technical, human and financial capacities of the MSIRM; to reduce the vulnerability.

Current activities of the MSIRM include a program on urban risk reduction, cooperation between cities (Bogota, Makati, Kathmandu), the training of community groups on risk management, campaigns for raising awareness and public information, implementation of mitigation works, changing from a reactive to a preventive view.

In this sense, the participatory workshop and the evaluation of the resilience of the city is also an opportunity to review the abilities of the MSIRM to identify, anticipate risks, and to cope with emergencies and recover from disasters. In the following sections the results of the questionnaire to community leaders and representatives of public institutions are presented. Main achievements within this context are also described.

3.2 Awareness and Advocacy

The objective of this theme is to identify the level of awareness and knowledge of earthquake risk in community leaders and public institutions. This theme encompasses the perception of the population regarding earthquake risk, the information available regarding earthquake safety and the development of trainings to increase abilities to identify and response in case of earthquakes.

3.2.1 Current status and main achievements of the MSIRM in risk assessment and raising public awareness

Hazard monitoring and microzonation

For monitoring seismic hazard, a seismological and an accelerographic network is operated and maintained by the Geophysics Institute at the National Polytechnic School-EPN (ANLAP 2005). On the other hand, with the financial support of the International Bank for Reconstruction and Development (IBRD)/ International Development Association (IDA), it was developed a seismic microzonation of the urban area of the MDQ (ERN 2012). Such study has been promoted within the framework of the Urban Risk Reduction program of the city. Also, in Beuval et al. (2014) a probabilistic seismic hazard assessment of Quito is presented.

Vulnerability and risk assessment

In 1995, the Project "Escenario Sísmico de Quito" was developed with the lead of the local government and the participation of various national and international institutions. In this study damage to buildings, roads, elements of the water supply system, power network and sewers were estimated (see Chatelain et al. 1999, EPN et al. 1995, Yépez 2001). Also, "The Quito School Safety Project" was developed to design the retrofitting alternatives for a representative sample of high-risk public schools in the city (see GeoHazards International 1995). In recent studies (Vaziri et al. 2012) Exceedance Probability Curves regarding seismic events were estimated for residential, commercial and industrial buildings in Quito.

During 2011 and 2012 a Project for the vulnerability assessment and risk reduction in Ecuador was promoted at the level of municipalities. Within this Project a methodology was applied for assessing vulnerabilities to earthquakes, volcanoes, floods and landslides, as well as common practices to reduce such vulnerabilities. Such methodologies and practices were applied in the Metropolitan District of Quito (Jalil 2013).

Public awareness, education, communication and formation

In the Urban Risk Reduction Program developed for the city[3], the following objectives were promoted within the component of applied research and communication:

- Include notions of risk in the curricula of schools and universities
- Improve the knowledge of citizens and decision makers regarding earthquake risk
- Promote campaigns for raising public awareness.
- Compilation of information about risk in order to be publicly available.
- Definition of a system and strategies of communications within the Metropolitan District.
- Design of educational campaigns.
- Design of protocols and procedures for communications.

[3] More details of the Urban Risk Reduction Program are provided in section 3.5.1.

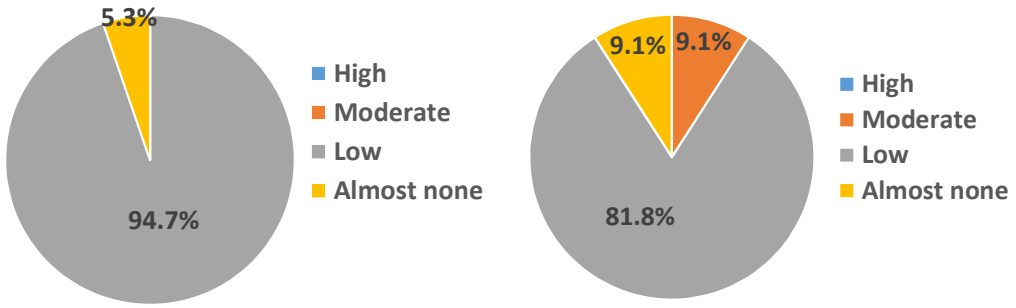
- Creation of handbooks for urban risk management: Protection of citizens regarding natural and anthropogenic hazards.
- Establishment of local systems of information about risks.
- A study of risk perception with community leaders
- An international workshop on integral safety
- 3 guidelines: citizen safety, risk management and road safety. Application in two sectors at the north and south of Quito: Santa Maria and Eloy Alfaro. Conformation of neighborhood safety committees and emergency plans. Participation of NGO's in the process.
- -8 bulletins on risk management.
- 400 drills in schools, 100 in neighborhoods and 1 per zonal administration.
- Exchange of risk management activities with other cities (Macati, Kathmandu).
- Participation of the city in the campaign of resilient cities.

3.2.2 Level of awareness and knowledge of earthquake risk

Figure 8 presents the scoring for both community leaders and governmental institutions regarding the level of awareness and knowledge of earthquake risk. More than 80% of the participants consider that a low proportion of the community is concerned about potential damages due to earthquakes.

Question: How many people in your Parish are concerned about an earthquake causing damage that will impact their life and property?

High	Moderate	Low	Almost none
Almost all	Many	A few	None



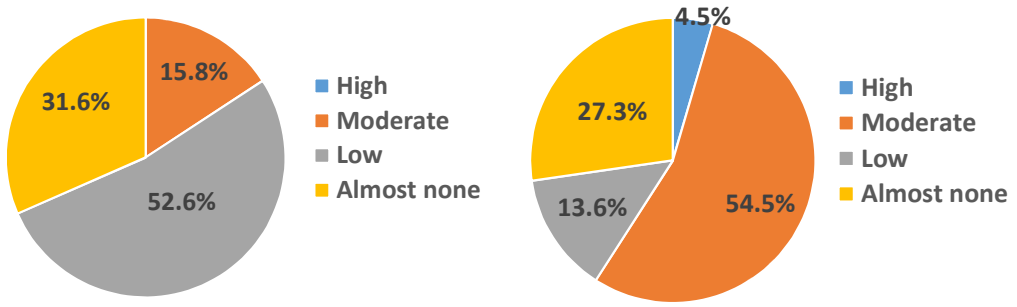
(a) Community leaders (b) Governmental institutions

Figure 8 level of awareness and knowledge of earthquake risk

3.2.3 Information about earthquake safety, preparedness, and risk reduction

Figure 7 presents an evaluation of community leaders and governmental institutions regarding information about earthquake safety, preparedness, and risk reduction. Most of the community leaders consider that the availability of such information is between low (52%) and almost none (31.6%). In the case of the governmental institutions, they considered a moderate availability (54%). This difference shows that the institutions working in earthquake risk management are more familiar with the public campaigns developed and promoted. Therefore, it is necessary to continue the communication of such initiatives to the public.

Question: Are mechanisms available for people to inform themselves about earthquake safety, preparedness, and risk reduction (media, brochures, flyers, public notice boards)?			
High	**Moderate**	**Low**	**Almost none**
Are available and highly visible at different locations in your Parish	Are available and somewhat visible in some locations in your Parish	Are available upon request only	Are not available



(a) Community leaders

(b) Governmental institutions

Figure 9 Information about earthquake safety, preparedness, and risk reduction

3.2.4 Public outreach activities informing about disaster safety, preparedness and risk reduction

Figure 10 presents the scoring of community leaders and governmental institutions regarding public outreach activities informing about disaster safety, preparedness and risk reduction. Most of the participants scored such activities between low and almost none. Therefore, efforts are still necessary in order to inform a wider audience about campaigns such as those promoted in the Urban Risk Reduction Program.

Question: Do public outreach activities exist for the general public to inform themselves about disaster safety, preparedness and risk reduction (e.g. earthquake safety drills and demonstrations, or meetings in neighborhoods on family emergency planning)?			
High	**Moderate**	**Low**	**Almost none**
Often and regularly held with widespread participation	Sometimes held with some participation	Rarely held with limited participation	Never held

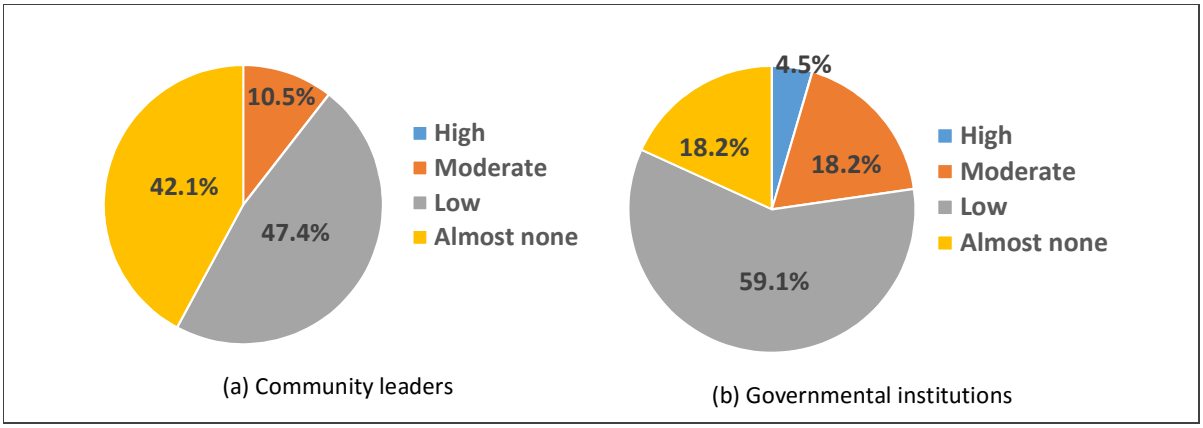


Figure 10 Public outreach activities to inform about disaster safety, preparedness and risk reduction

3.2.5 Participation in public outreach services about disaster safety, preparedness and risk reduction

Figure 11 presents the scoring of community leaders and governmental institutions regarding their participation in public outreach services about disaster safety, preparedness and risk reduction

Question: Have you or someone you know participated in public outreach services to be informed about disaster safety, preparedness and risk reduction

High	Moderate	Low	Almost none
In most cases	In some cases	In a few cases	Never

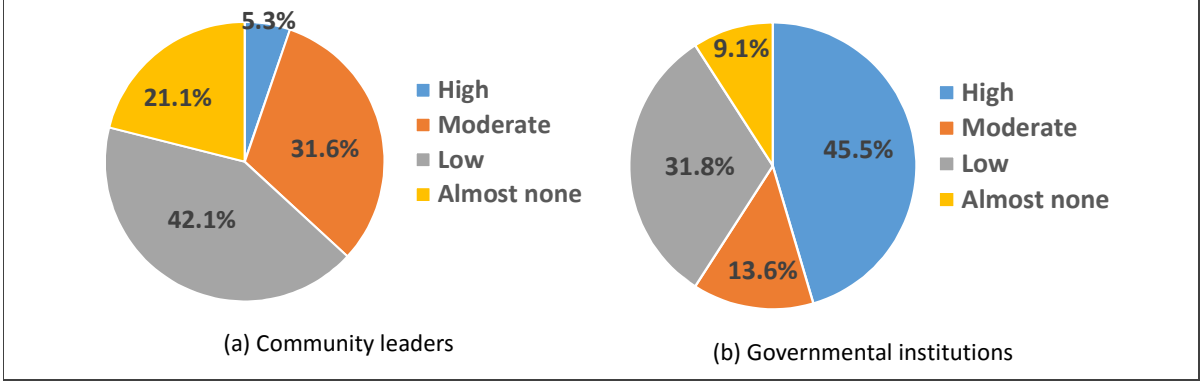


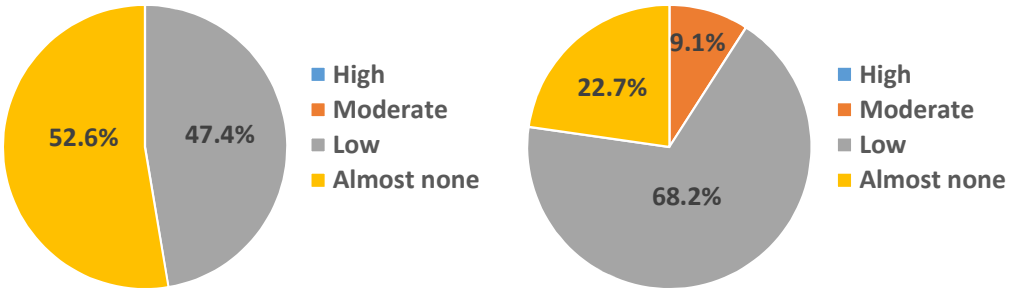
Figure 11 Participation in public outreach services about disaster safety, preparedness and risk reduction

3.2.6 Trainings and capacity building programs to increase technical and professional resources for earthquake risk reduction

Figure 12 presents the scoring of community leaders and governmental institutions regarding trainings and capacity building programs to increase technical and professional resources for earthquake risk reduction.

Question: To what extent have trainings and capacity building programs to increase technical and professional resources for earthquake risk reduction been put in place?

High	Moderate	Low	Almost none
Many different types of programs that are effectively implemented and regularly reviewed	Some programs, implemented periodically	Limited programs offered sporadically	No programs



(a) Community leaders (b) Governmental institutions

Figure 12 Trainings and capacity building programs to increase technical and professional resources for earthquake risk reduction

By using the evaluations from community leaders, scores for Awareness and Advocacy were obtained by Parishes (see Figure 13). Also, an average of the results of the governmental institutions is included.

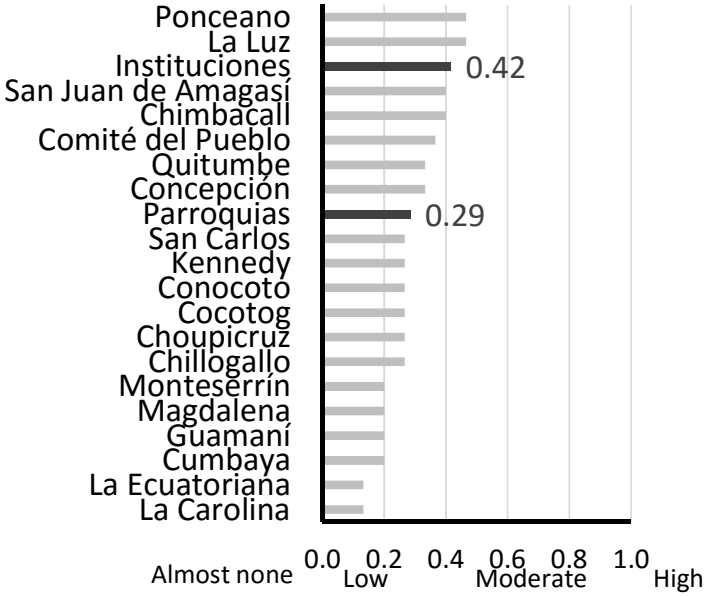


Figure 13 Awareness and Advocacy: summary of results by Parishes

Most of the scores provided by representatives of the communities vary between almost none (32%) to low (57%). More optimistic evaluations have been obtained from participants from governmental institutions; such persons are aware of the efforts and programs available in order to identify and communicate risks and enhance the capacity of the population. Efforts could be addressed in order to

have a wider coverage and frequency of trainings and services to inform people about earthquake risk management.

3.3 Social capacity

The objective of this theme is to identify the capacities of the population to efficiently prepare, respond and recover from a damaging earthquake. This theme encompasses resources for social assistance to the community, integration within the population, interaction between private and governmental institutions with the community, the participation of community leaders in decision-making and the protection of historical buildings and cultural heritage. The status and current achievements for these topics, as well as the scores obtained in the workshop are presented in the following sections.

3.3.1 Healthcare and social assistance programs available for vulnerable groups

Table 4 presents the population (total and percentages) by type of health insurance, considering the Institute of social insurance of the Army (ISSFA), the Institute of social insurance of the Police (ISSPOL) and the Ecuadorian Institute of Social Insurance (IESS). From this table it is possible to observe that near 48% of the total population does not have any health insurance.

Table 4 Population by affiliation to health insurance

Total population	ISSFA	ISSPOL	IESS General insurance	IESS Volunteer Insurance	IESS Peasant Insurance	Retired from IESS/ISSFA/ISSPOL	Not affiliated	Unknown
2239191	12312	8325	473086	33011	6253	58493	1091945	61807
100%	0.5%	0.4%	21.1%	1.5%	0.3%	2.6%	48.8%	2.8%

Source: Census 2010.

Figure 14 presents scores of community leaders and governmental institutions regarding healthcare and social assistance programs for vulnerable groups. Participants consider that the availability of such programs is low to moderate.

Question: Are healthcare and social assistance programs available for vulnerable groups (e.g. free clinics)?

High	Moderate	Low	Almost none
Many programs with excellent service	Few programs with good service	Limited programs with poor service	No programs

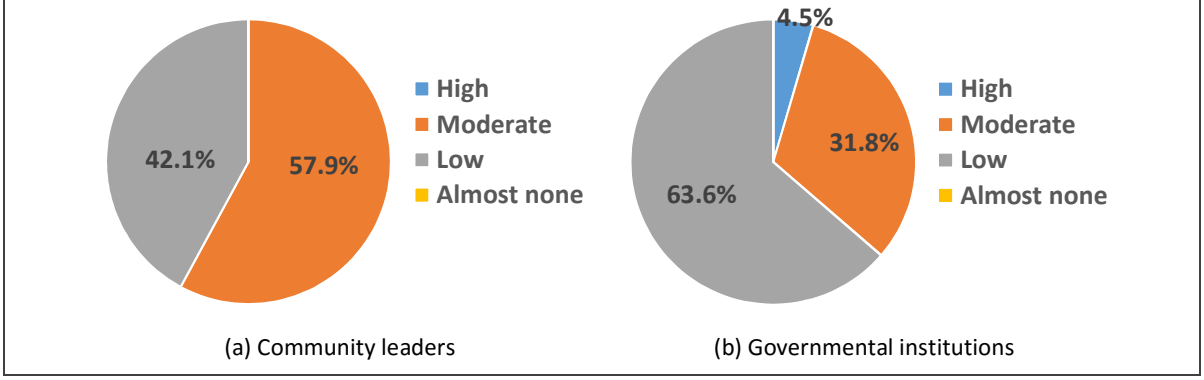


Figure 14 Healthcare and social assistance programs available for vulnerable groups

3.3.2 Ties and connections between people in the Parish

Figure 15 presents scores of community leaders and governmental institutions regarding ties and connections between people in the Parishes. Many of the participants (more than 50%) consider that most people do not know each other at all. In this regard, the promotion of community emergency plans and emergency drills could be useful to increase the interaction and cooperation within the communities.

Question: What degree of ties and connections exist between people in your Parish?

High	Moderate	Low	Almost none
Most people know each other well and many have strong ties	Most people know each other well and a few have strong ties	Some people know each other but few have strong ties	Most people do not know each other at all

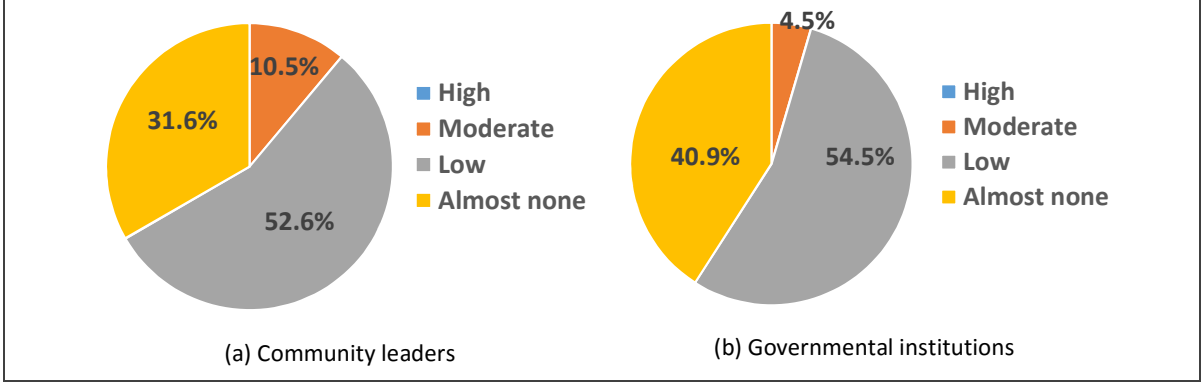


Figure 15 Ties and connections between people in the Parish

3.3.3 Social integration considering different economic levels

According to the National Institute of Statistics of Ecuador, in June 2015 the GINI Index for Quito was estimated in 0.43[4] and the rate of incidence of poverty (regarding income) was around 6%. Low-income

[4] In which 0 represents perfect equality of the distribution of the income and 1 means complete inequality (the income is concentrated in only person/group).

dwellings are usually located in three types of settlements: (i) at the edge of the urban area; (ii), in deteriorated tenements in the historic center, and (iii) in surrounding towns. In the northern and southern peripheries of the city, it is frequent that owners built their houses with inadequate materials, under illegal conditions (Carrion et al. 2003).

Figure 16 presents the scoring of community leaders and governmental institutions regarding social integration considering different socioeconomic levels. In Quito, the Secretariat of Social Inclusion is responsible for promoting programs for eliminating child work, inclusion of gender, youth and disabled populations and eliminating poverty. Within such programs, specific activities could be developed in order to promote a better connection between neighbors.

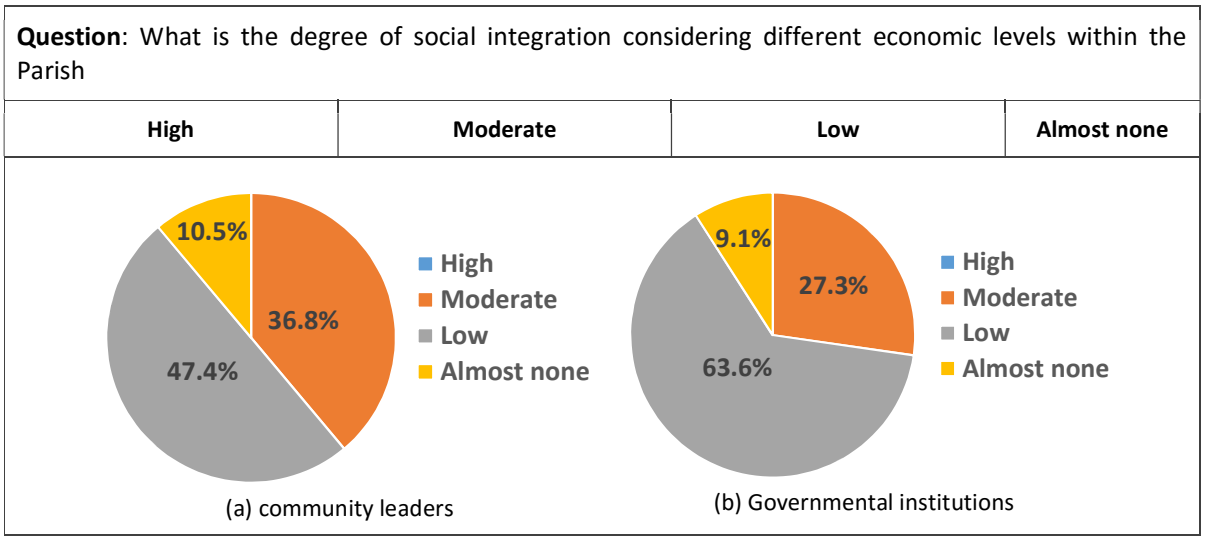


Figure 16 Social integration considering different economic levels

3.3.4 Access to electricity, gas, and clean water

Table 5 presents percentages of dwellings with access to public services in Quito. From this Table it is possible to observe that there is a high access to electricity, waste disposal and drinking water (more than 95% of coverage). Almost all of the population uses gas cylinders to cook. The public service with a lower coverage corresponds to paved roads.

Table 5 Access to public services (% of dwellings)

Drinking water-Public network)	Drinking water-pipe within the house)	Sewage system - Public network	Waste disposal-Collecting truck)	Electric power	Toilet Exclusive	Fuel used to cook (Gas)	Telephone	Pavement (asphalt, concrete, cobble)
96,0	84,1	90,9	96,5	99,4	88,5	96,6	62,2	75,3

For low income and illegal settlements, the access to such services is limited. According to Carrion et al. (2003) such settlements are characterized by a deficit or inefficient systems of drinking water, sewage, waste disposal, roads and street lighting. Figure 17 presents neighborhoods of Quito by percentages of population with Unsatisfied Basic Needs. From this Figure it is possible to identify larger percentages of dwellings with limited access to services in the peripheral areas of the city (La Delicia, Norte, Tumbaco).

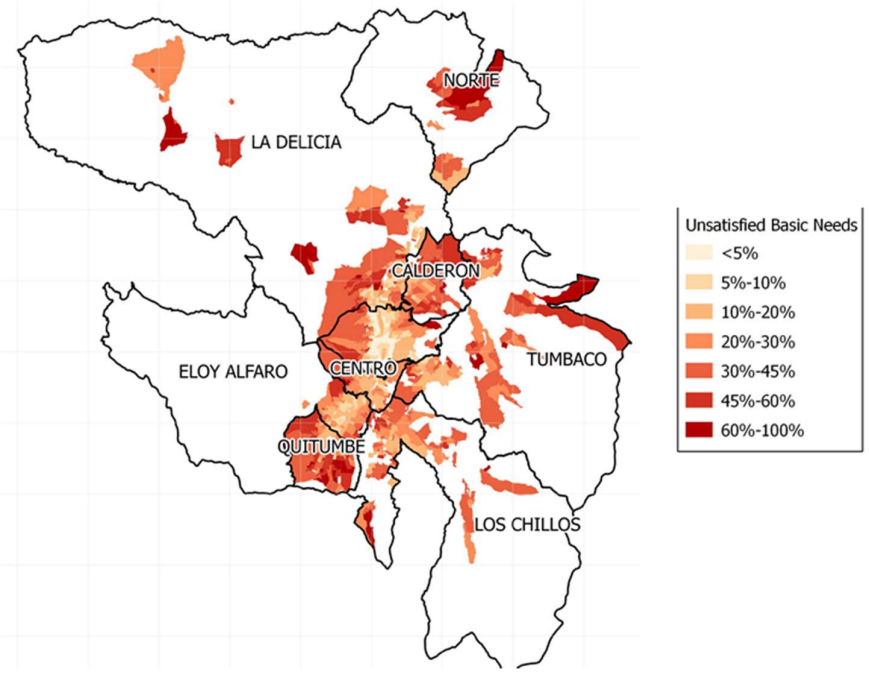
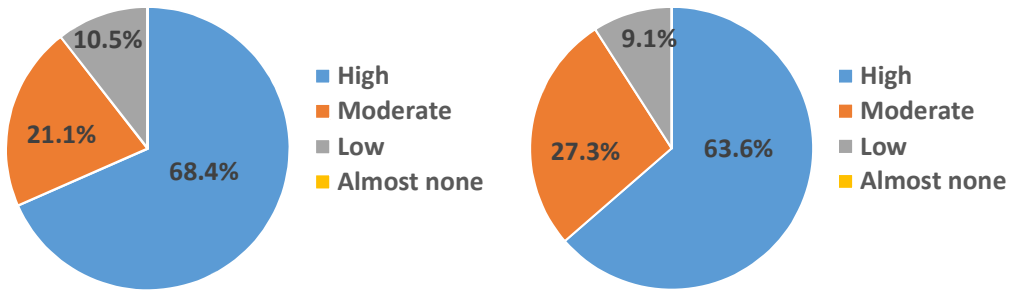


Figure 17 Population by Unsatisfied Basic Needs (neighborhoods)

Figure 18 presents the scores from community leaders and governmental institutions regarding the access to electricity, gas, and clean water. More than 60% of the participants consider that there is a high access; more than 20% scored moderate and around 10% scored low. Such results are similar to those presented in Table 5. This information of the coverage and access to public services could be considered for emergency and contingency plans, in order to supply the needs of vulnerable and affected populations after earthquake events.

Question: What is the level of access of your Parish's population to electricity, gas, and clean water?

High	Moderate	Low	Almost none
Widespread access	Some access	Limited access	Very little access



(a) Community leaders (b) Governmental institutions

Figure 18 Access to electricity, gas, and clean water

3.3.5 Primary education

According to statistics of the Ministry of Education of Ecuador for 2013, the total number of educational facilities in Quito of primary, basic and secondary school level were 1,649. For such levels of instruction, the total number of students was 595,293. Table 6 presents the number of inhabitants and percentages to the total population by level of instruction. From this Table it may be noted that at least 60 % of the population has at least a basic education.[5]

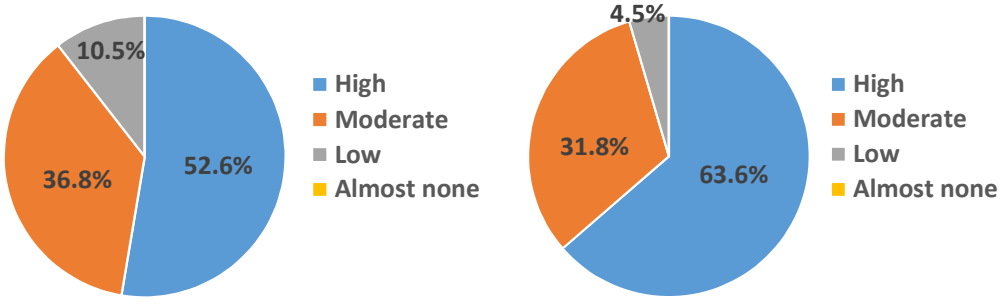
Table 6 Population by level of instruction

None	Literacy Centers	Preschool	Primary	Secondary	Basic	Medium	High school	Superior	Unknown	Total
48484	7664	19166	563674	499175	136480	194029	24902	458480	36199	2037454
2.4%	0.4%	0.9%	27.7%	24.5%	6.7%	9.5%	1.2%	22.5%	1.8%	100.0%

Figure 19 presents the scoring of community leaders and governmental institutions regarding the access to primary education. Between 50 to 60% of the participants consider that almost all of the people have reached this level; between 31% and 36% consider that this access is moderate and 5-10 % scored low. Such condition could be considered in plans for post-earthquake emergency operations for productivity and livelihoods, as well for education, culture and environment.

Question: How many people in your Parish have at least a primary education?

High	Moderate	Low	Almost none
Almost all	Many	A few	None



(a) Community leaders (b) Governmental institutions

Figure 19 Primary education

3.3.6 Social integration of minority populations

Table 7 presents the distribution of population within cultural groups in Ecuador. From this Table, it is possible to observe that near 8% of the population belongs to indigenous groups, Afro-ecuadorian, afro- and mulatto. The geographical distribution of population of ethical groups is presented in Figure 20.

[5] It corresponds to the sum of the shaded cells (Literacy centers, Preschool, Primary, Secondary, Basic)

Table 7 Population by cultural groups (self-identification)

Indigenous	Afro-ecuadorian	Afro	Mulatto	Coastal peasant	Half blood	White	Other	Total
91478	59113	11281	34365	30387	1853203	150678	8686	2239191
4.1%	2.6%	0.5%	1.5%	1.4%	82.8%	6.7%	0.4%	100.0%

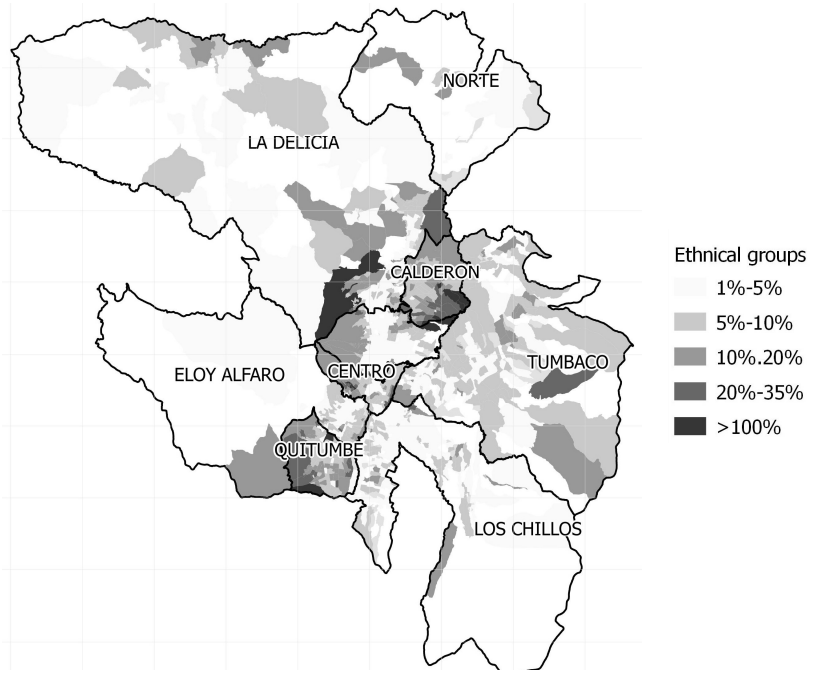
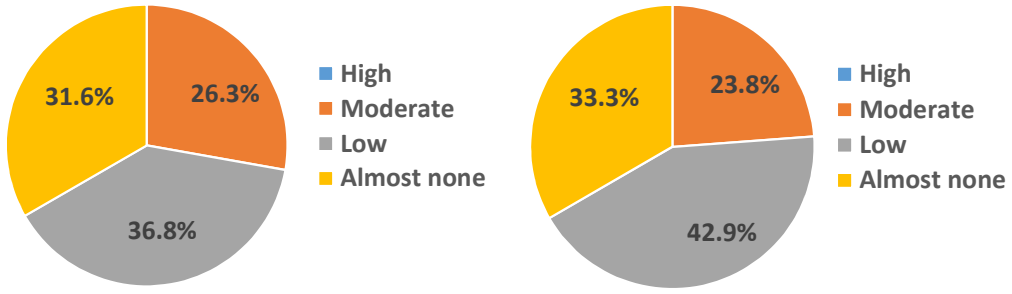


Figure 20 Population by ethnical groups (neighborhoods)

Figure 21 presents the scoring of community leaders and governmental institutions regarding the social integration of minority populations. Around 30% of the participants scored almost none; between 36% and 42% scored low and around 24% scored moderate.

Question: What is the degree of social integration of minority populations (Indigenous and Afro-Ecuadorian) within the Parish?

High	Moderate	Low	Almost none



(a) Community leaders (b) Governmental institutions

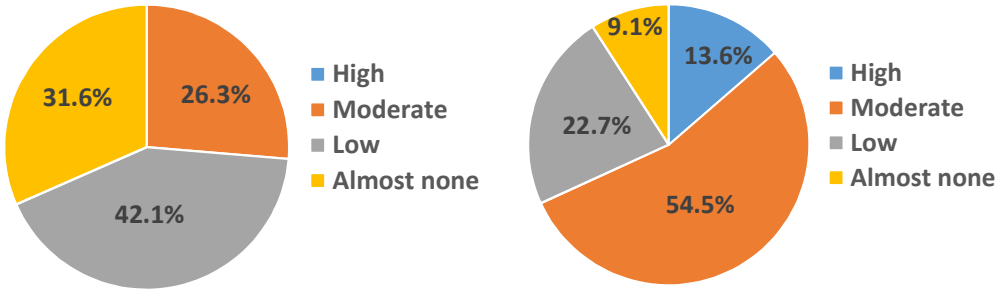
Figure 21 Social integration of minority populations

3.3.7 Interaction between formal (governmental) and informal institutions

The Metropolitan System of Risk Management was created in order to facilitate the interaction between community leaders, private and public institutions, as established in the ordinance 0265 of 2008. Figure 19 presents scores of both community leaders and governmental institutions regarding the interaction between formal and informal institutions.

Question: What is the level of interaction between formal (governmental) and informal institutions?

High	Moderate	Low	Almost none
Widespread	Some	Few	Almost none



(a) Community leaders (b) Governmental institutions

Figure 22 Interaction between formal (governmental) and informal institutions

In this case, it is observed that 54% of the representatives from governmental institutions consider a moderate interaction and around 13% consider it high; the remaining scored between low (22%) and almost none (9%). On the other hand, 42% of the community leaders consider it low and 31% scored almost none. Such differences in the results shows a lack of knowledge of members of the Parishes about the alternatives and mechanisms of interaction between formal and informal institutions.

3.3.8 Participation in decision making

As a compliment to the previous question, Figure 23 presents the scores regarding the participation of members of the Parishes in decision making. In this case, near the 65% of the participants consider a low participation; between 27% and 31% scored almost none and around 5% scored high. These results suggest the need to promote a wider participation of community leaders in projects for earthquake risk management.

Question: To what extent are residents in your Parish effectively engaged and heard in decisions made by authorities?

High	Moderate	Low	Almost none
Just about always	Most of the time	Some of the time	Never

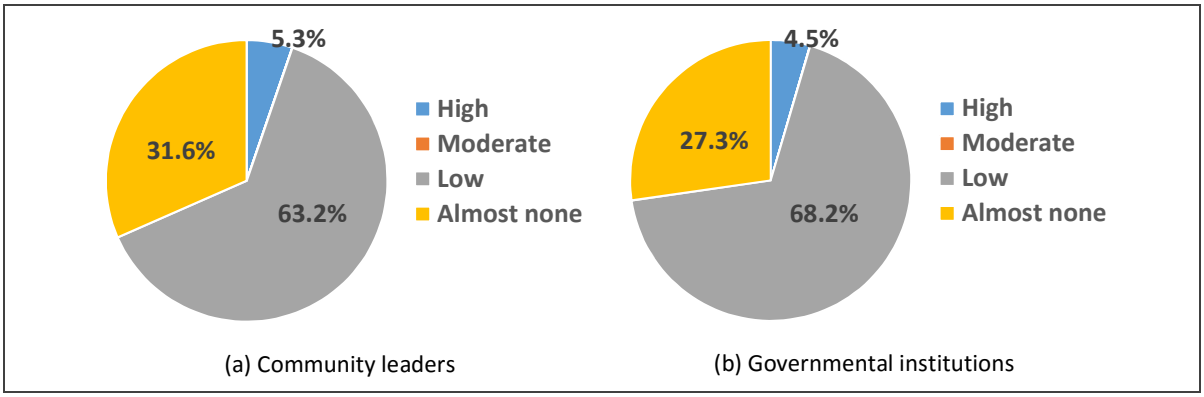


Figure 23 Participation in decision-making

3.3.9 Programs for the protection of historic buildings and cultural heritage

Various efforts and public programs have been promoted for the protection of historic buildings in Quito. Studies for the retrofitting of churches were developed (FERNANDO ROMO CONSULTORES CIA LTDA 1989), for instance. Also, a seminar on the protection of historical heritage took place in 2003 (FONSAL 2004). Recently the Metropolitan Institute of heritage has also begun promoting programs for the rehabilitation of roofs and facades of patrimonial buildings. For such programs the municipality is offering subsidies and tax benefits for the owners.

Figure 24 presents the scoring of community leaders and governmental institutions regarding programs for the protection of historic buildings and cultural heritage.

Question: Are special programs in place to protect historic buildings and cultural heritages if a damaging earthquake were to occur?

High	Moderate	Low	Almost none
Programs are in place to protect both private and public historic buildings and cultural heritage	Programs are in place to protect only public historic buildings and cultural heritage	Only on an individual bases historic buildings and cultural heritage are preserved	No preservation programs exist

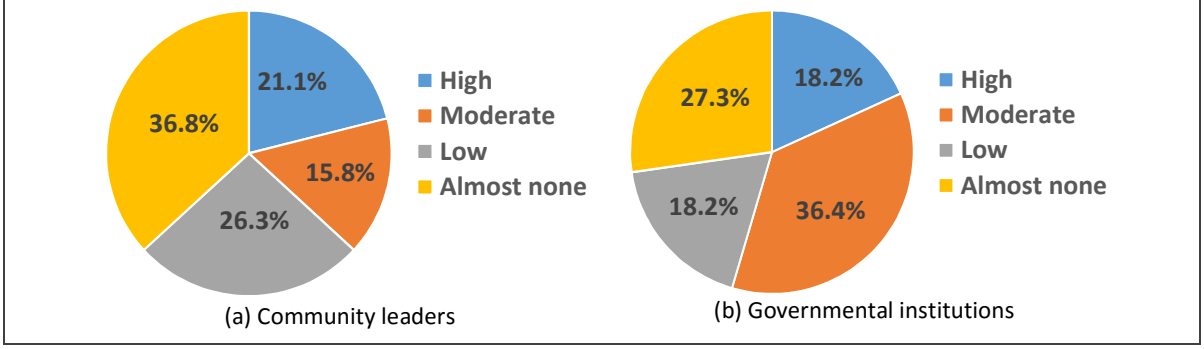


Figure 24 Programs for the protection of historic buildings and cultural heritage

Results shows that 36% of the community leaders and 27% of the representatives of governmental institutions consider no preservation programs exist for the protection of cultural heritage. Given that

there are programs currently promoted, an improved communication of the results and benefits of such efforts is recommended. In addition, given the city's historic and heritage value, technical and financial resources could be promoted for the retrofitting of public and private buildings.

By using the evaluations from community leaders, an index of Social Capacity was developed for Parishes (see Figure 25). The average of the results of the governmental institutions has been included. Similar results have been obtained for the two groups. In general, the scores vary between low (25%) to moderate (37%). There is an agreement on the socioeconomic conditions of the city and the participation of community leaders in decision-making.

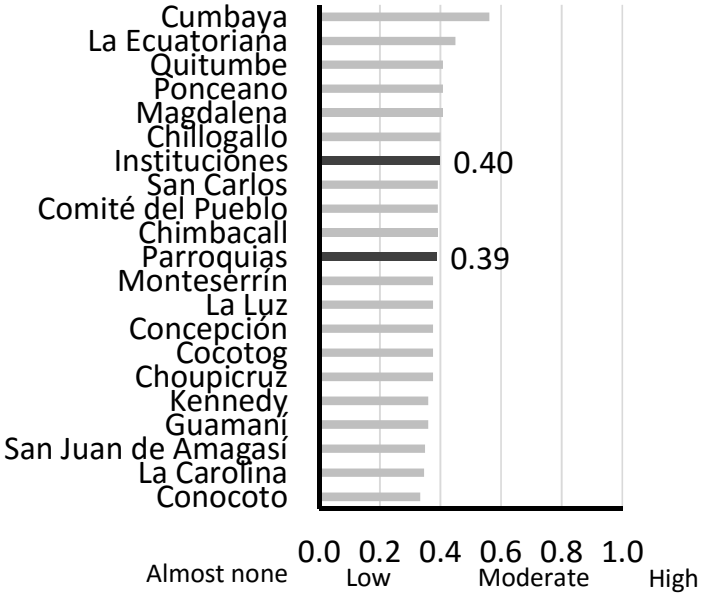


Figure 25 Social capacity: summary or results by Parishes

3.4 Legal and Institutional Arrangements

The objective of this theme is to identify how effective mechanisms are at advocating earthquake risk reduction in the city. This theme encompasses regulations for earthquake risk reduction, participation of community leaders, mechanisms of coordination between parishes, private and public organizations, and the confidence of public and private institutions in risk management. The status and current achievements in such topics, as well as the scores obtained in the workshop are presented in the following sections.

3.4.1 Current status and main achievements of the MSIRM about legal and institutional arrangements

As mentioned before, through the Metropolitan Ordinance 0265 of 2008, the Metropolitan System for Integrated Risk Management of the Metropolitan District of Quito was established. Through this ordinance objectives, structure and functions related to risk reduction were defined. Other relevant legal instruments for disaster risk management at the national level are listed in Table 8.

Table 8 Legal instruments for disaster risk management

National Secretariat of Planning and Development (SENPLADES)	Reduction of disaster risks has been included as a policy for the development of the country in order to achieve the Millennium Goals.
National Constitution of Ecuador	Art. 389 and 390: main mandate for disaster risk management for public and private sectors and citizens.
Public and State Safety Law	Coordination of risk management activities through the National Secretariat of Risk Management. Definition of emergency situations and responsibilities for prevention and response.
Regulation of the Public and State Safety Law	Definition of decentralized Emergency Operation Committees
Land Use Code(COOTAD)	- To regulate and to control building construction, verifying in particular safety standards regarding prevention of risks. - The land use code of the municipalities could include the assessment of disaster risks.
Planning and Public Finance Code	Incorporation of risk management programs in public budgets and investments
National Plan for Well-being.	Promotes the reduction of social and environmental vulnerability. Introduction of risk management in urban planning Implementation of programs for emergency response
National Plan of Integral Safety	Promotes the vulnerability reduction of communities through the implementation of awareness programs among educational and public institutions, developing a culture on risk management, promoting the interaction between technical institutions for hazard assessment and coordinating activities for response and recovery.

Source Proaño-Castro (2012)

3.4.2 Regulations, ordinances, or incentives for earthquake safety and risk reduction

Figure 26 presents the scoring for community leaders and governmental institutions regarding the effectiveness of regulations, ordinances, or incentives for earthquake safety and risk reduction. At least 60% of the participants consider that such regulations exist but they have not been implemented. This result shows that legal instruments described in section 3.4.1 have not been introduced into specific projects or have not been widely disseminated.

Question: Have regulations, ordinances, or incentives for earthquake safety and risk reduction been effective for your Parish?			
High	**Moderate**	**Low**	**Almost none**
Most regulations have been fully implemented	Some regulations have been implemented	Regulations exist but they have not been implemented	Regulations do not exist

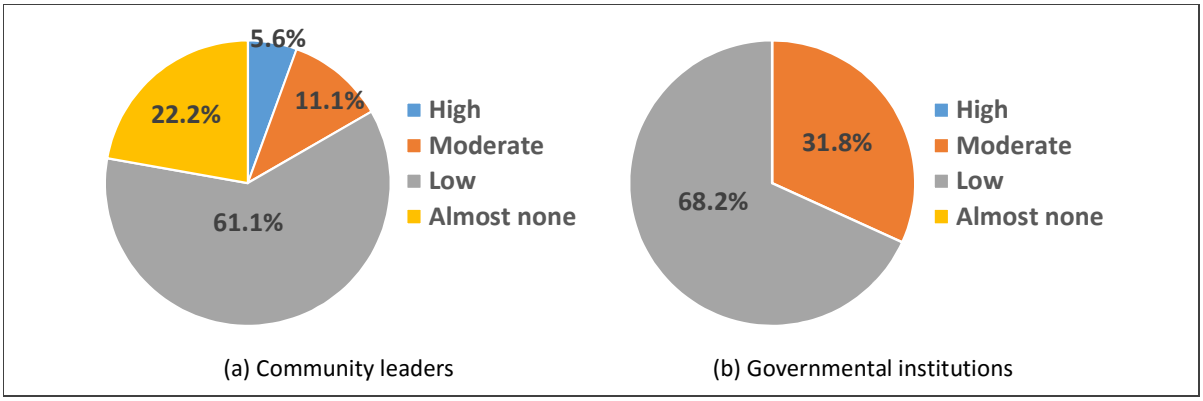


Figure 26 Regulations, ordinances, or incentives for earthquake safety and risk reduction

3.4.3 Community leaders with roles and responsibilities for Disaster Risk Reduction

Figure 24 presents the scoring for community leaders and governmental institutions regards roles and responsibilities of community leaders for disaster risk reduction. Around 66% of the participants of community leaders consider that there are no persons with such functions; 22% scored low. On the other hand, 36% of the participants from governmental institutions scored low and 36% consider it moderate. Such differences are also related with the low participation in decision making as well as the confidence of the community leaders in public and private institutions for disaster risk management.

Question: Are there people within the parish with clear roles and responsibilities for Disaster Risk Reduction (DRR)?

High	Moderate	Low	Almost none
There are designated and trained persons whose main function is DRR	There are designated and trained persons, but their main function is not DRR	There are persons without training or expertise and their main function is not DRR	There are no persons with such functions

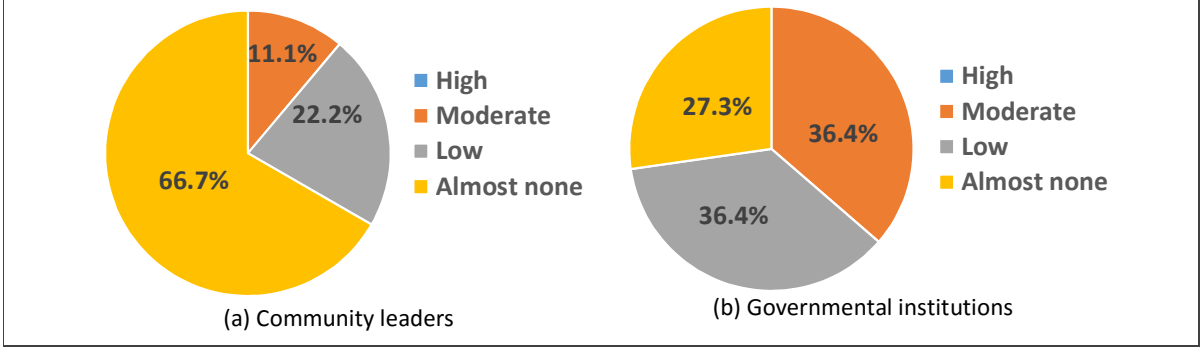


Figure 27 Community leaders with roles and responsibilities for Disaster Risk Reduction

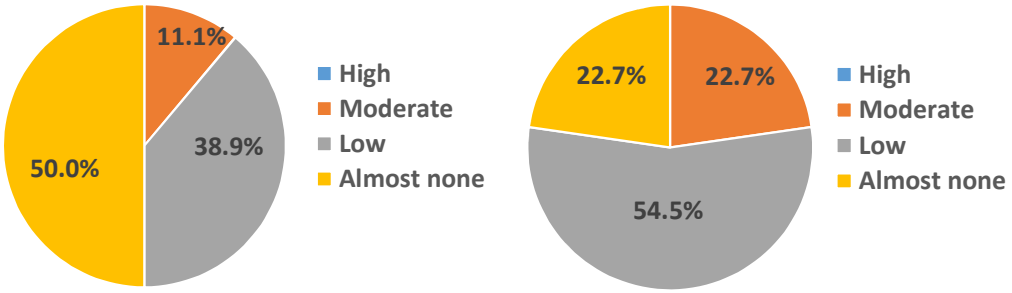
3.4.4 Mechanisms of coordination and cooperation for disaster preparedness, safety and risk reduction

The coordination between different sectors for disaster risk management is promoted by the Ordinance 0265 o 2008. In particular, the Operative Committee of Emergencies could ask for the collaboration of communities, public, and private institutions.

Figure 28, Figure 29 and Figure 30, presents the scores of community leaders and governmental institutions regarding mechanisms of coordination and cooperation for disaster preparedness, safety and risk reduction between parishes; parishes and the Municipality; parishes and Private Enterprises.

Question: To what extent are there well-defined mechanisms of coordination and cooperation for disaster preparedness, safety and risk reduction between your parish and neighboring parishes?

High	Moderate	Low	Almost none
Very strong coordination and excellent cooperation	Somewhat strong coordination and cooperation	Limited coordination and weak cooperation	No coordination or cooperation



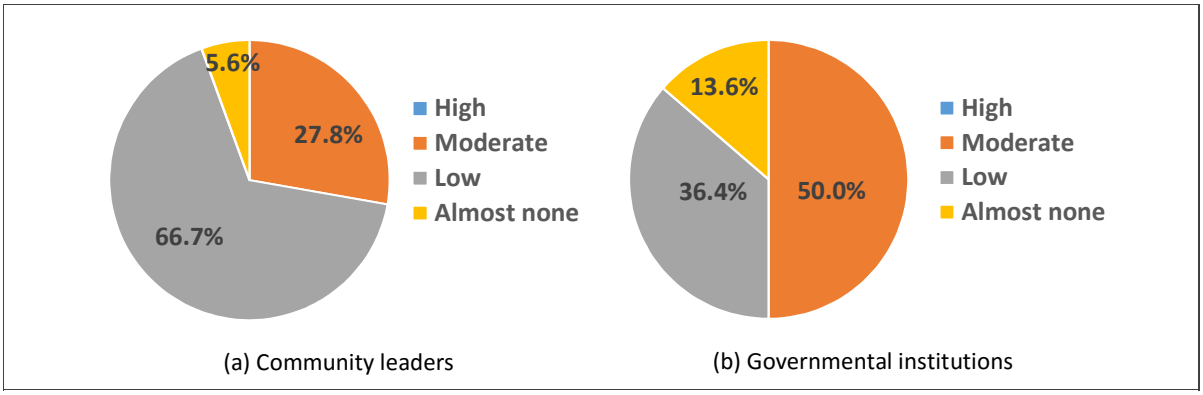
(a) Community leaders

(b) Governmental institutions

Figure 28 Mechanisms of coordination and cooperation for disaster preparedness, safety and risk reduction between parishes

Question: To what extent are there well-defined mechanisms of coordination and cooperation for disaster preparedness, safety and risk reduction between your Parish and the municipality?

High	Moderate	Low	Almost none
Very strong coordination and excellent cooperation	Somewhat strong coordination and cooperation	Limited coordination and weak cooperation	No coordination or cooperation

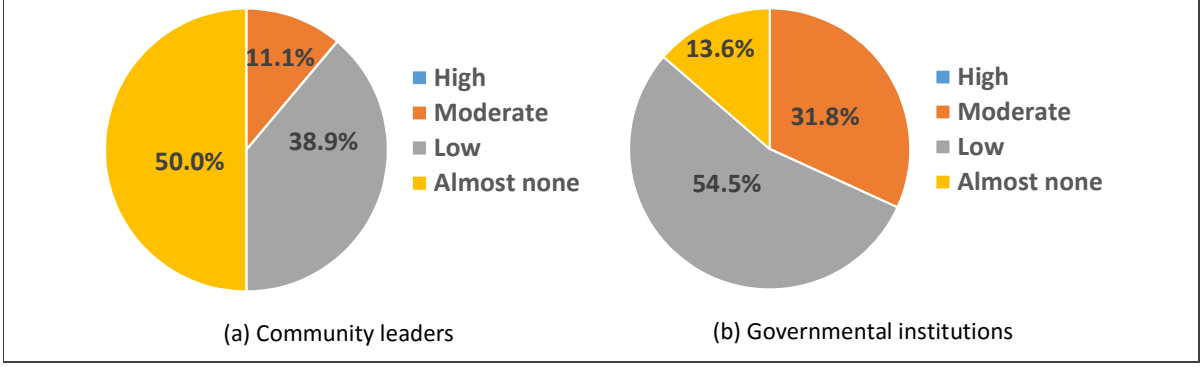


(a) Community leaders (b) Governmental institutions

Figure 29 Mechanisms of coordination and cooperation for disaster preparedness, safety and risk reduction between Parishes and the municipality

Question: To what extent are there well-defined mechanisms of coordination and cooperation for disaster preparedness, safety and risk reduction between your Parish and Private enterprises?

High	Moderate	Low	Almost none
Very strong coordination and excellent cooperation	Somewhat strong coordination and cooperation	Limited coordination and weak cooperation	No coordination or cooperation



(a) Community leaders (b) Governmental institutions

Figure 30 Mechanisms of coordination and cooperation for disaster preparedness, safety and risk reduction between parishes and Private Enterprises

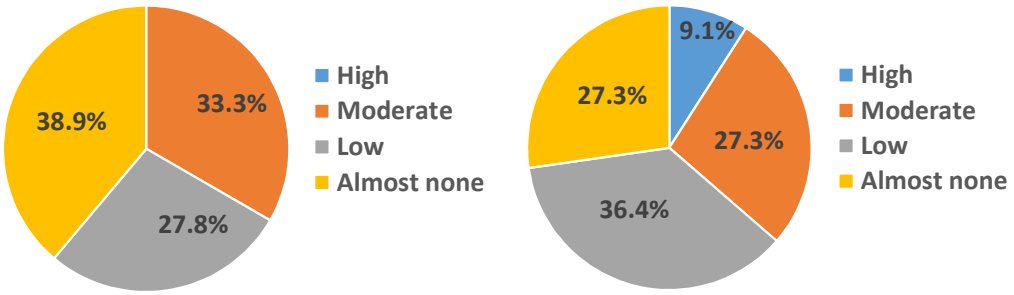
From this Figures, it is possible to observe that 50% of the participants of community leaders consider that no mechanism exists for the collaboration between parishes and private enterprises. The coordination of parishes with the municipality is considered better; nevertheless, it still is considered low. On the other hand, the majority of the participants from governmental institutions scored between moderate and low. Again, the results suggest that communities are not aware of the alternatives for coordination for disaster risk management.

3.4.5 Confidence in the central and local government and non-governmental institutions to prepare for, respond and recover from a damaging earthquake

Figure 31, Figure 32 and Figure 33 is a delineation of the confidence in the central and local governments and non-governmental institutions for response and recovery from earthquake events.

Question: How much confidence do you have in the central government to prepare for, respond and recover from a damaging earthquake?

High	Moderate	Low	Almost none
Widespread confidence	Some confidence	Limited confidence	Very little confidence

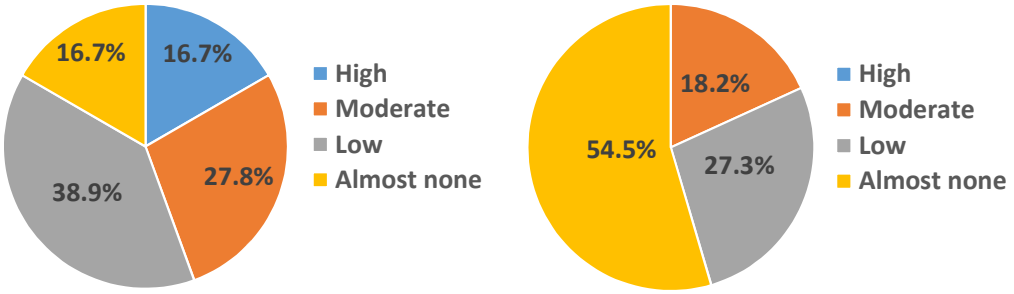


(a) Community leaders (b) Governmental institutions

Figure 31 Confidence in the central government to prepare for, respond and recover from a damaging earthquake

Question: How much confidence do you have in the local government to prepare for, respond and recover from a damaging earthquake?

High	Moderate	Low	Almost none
Widespread confidence	Some confidence	Limited confidence	Very little confidence



(a) Community leaders (b) Governmental institutions

Figure 32 Confidence in the local government to prepare for, respond and recover from a damaging earthquake

Question: How much confidence do you have in non-governmental institutions (NGO's) acting jointly to prepare for, respond and recover from a damaging earthquake?

High	Moderate	Low	Almost none
Widespread confidence	Some confidence	Limited confidence	Very little confidence

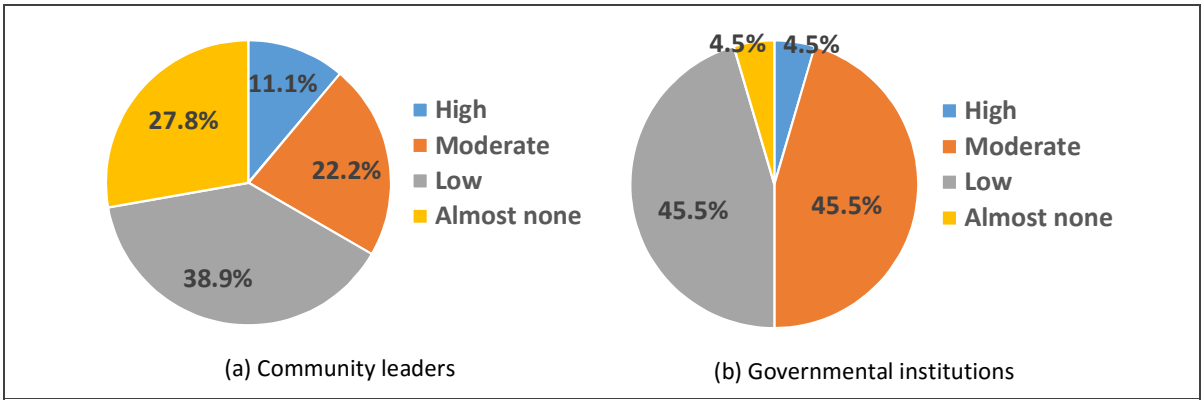


Figure 33 Confidence in non-governmental institutions (NGO's) acting jointly to prepare for, respond and recover from a damaging earthquake

The results shows a lack of trust in the government (both the local and the central). Nearly 55% of the community leaders have a low or almost no confidence in the local government. Also, it is possible to observe that community leaders rely more on the local government and non-governmental institutions than on the central government. On the other hand, participants from public institutions rely more on the central government than the local. Also, this group has more confidence on NGO's than in the local government. The results show the need for strengthening the confidence of the community in the government.

By using the evaluations from community leaders, an index of Legal and Institutional arrangements has been obtained for the parishes (see Figure 34). An average of the results of the governmental institutions was included. In this case, participants from governmental institutions declared a slightly more optimistic evaluation in which most of the scores provided by representatives from the communities vary between low (43%) to almost none (33%).

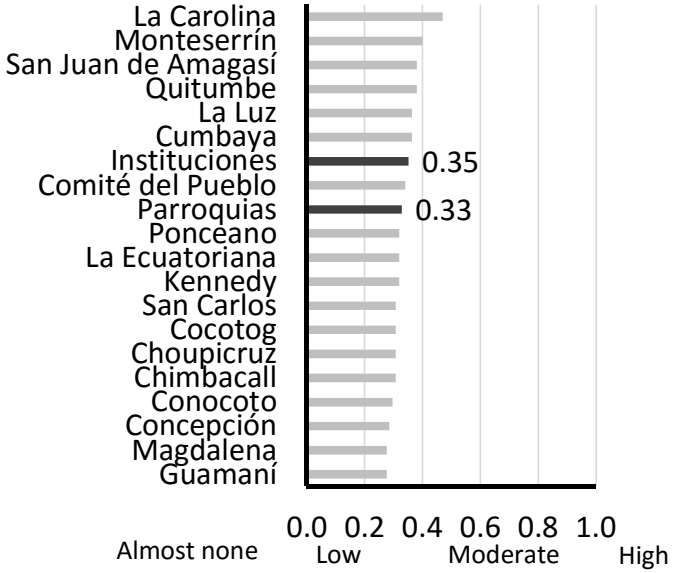


Figure 34 Legal and Institutional arrangements: summary of results by Parishes

3.5 Planning, Regulation, and Mainstreaming Risk Mitigation

The objective of this theme is to identify the perceived level of commitment and mainstreaming of disaster risk reduction through regulatory planning tools in the city. This theme encompasses earthquake resistant building codes, the reinforcement of private infrastructure, the availability of insurance and funds for disaster risk management plans. The status and current achievements in such topics as well the scores obtained during the workshop and presented in the following sections.

3.5.1 Current status and main achievements of the MSIRM about planning, regulation and mainstreaming risk mitigation

Since 2009, the Metropolitan District of Quito, the United Nations for Development Program (UNDP) and the World Bank initiated the implementation of the Urban Risk Reduction Program for the city. This plan was established as a framework for decision makers in order to manage risks, with emphasis on the reduction of the vulnerability. The main components of this project are: development of a methodology in order to create a culture of prevention; to promote activities for risk reduction; institutional strengthening in risk reduction and risk management; to improve the information and communication for disaster risk reduction.

The plan encompasses the following approaches: 1) a prospective approach that is focused on the construction of safer places; 2) a corrective approach that is focused on the reduction of the current vulnerability; and 3) a reactive approach that is focused in the strengthening of local capacities and rapid response to emergencies. It is relevant to highlight that this initiative was conceived with a clear framework of institutional competences and the availability of financial resources. A scheme of the Urban Risk Reduction Program is presented in Figure 35 showing the development and use of risk scenarios for risk management.

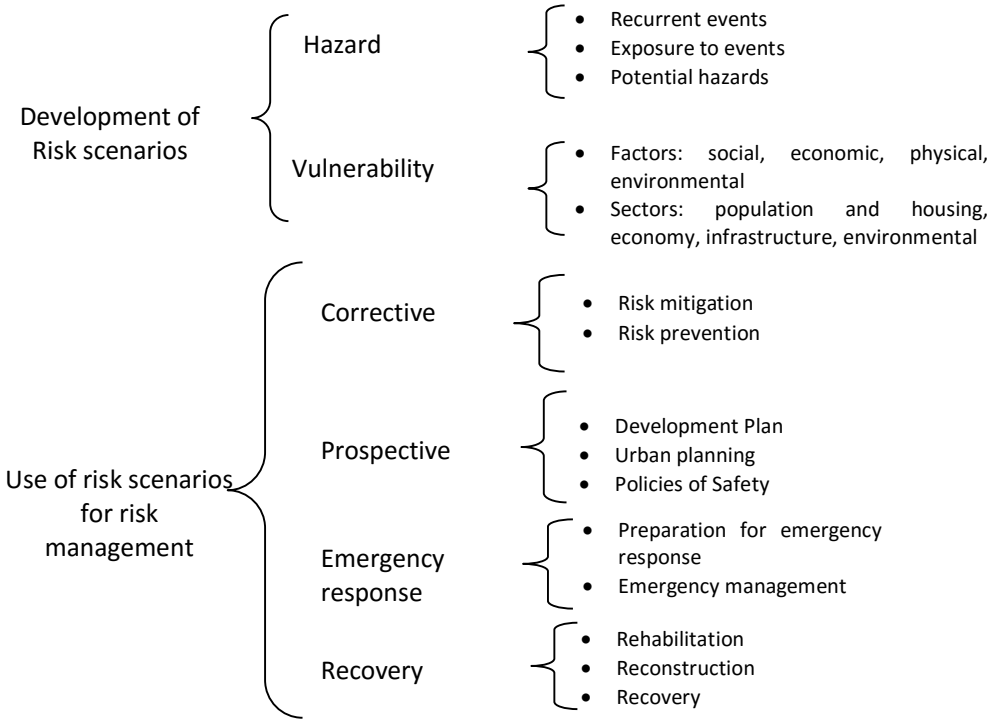


Figure 35 Scheme of the Urban Risk Reduction Plan

Some of the strategies and projects of this program related to risk reduction are listed below (see Table 9)[6]:

- *Urban planning*: focused on considering the seismic hazard for urban planning, development of mitigation programs, reallocation of population living in areas where it is not suitable of develop risk reduction activities, as well as the definition of strategies for seismic events.

- *Buildings*: retrofitting of buildings (especially pubic and sites of massive concentration of population) and the development of risk transfer instruments. Promotion of suitable and feasible reinforcement techniques according to the context of the city.

- *Public services and transportation systems:* promotes the evaluation of the seismic vulnerability of the infrastructure; the development of protocols in order to guarantee the functionality of public services and lifelines in case of earthquakes, as well as risk reduction and risk transfer programs.

Table 9 Projects included in the Urban Risk Reduction Program of Quito

Project	Description
Ecuadorian code of buildings construction	Updating of the Ecuadorian building code according to the context of the country and considering state of the art methodologies regarding seismic design and construction.
New system of approval of building plans.	A system for the review and approval of architectural and structural plans by the MDQ. Characteristics: simplified regime (construction of less than 40^2 meters); ordinary (for constructions between 40 and 5000 m^2), external review, professional associations, universities) More than 5000 m^2 or historical areas; special system; the Secretariat of Land, Habitat and housing will be the authority in charge.

Source (Jalil 2013).

The total invested amount of the project was around 1.24 million USD. The main achievements of this project are listed below (Jalil 2013):

- Based on the results of the seismic microzonation of the city, the Secretariat of Land, Habitat and Housing issued a regulation in order to control the design and construction of buildings in Quito.
- Development of a seismic risk plan for the Metropolitan District of Quito (MDQ).

3.5.2 Earthquake resistant building construction codes

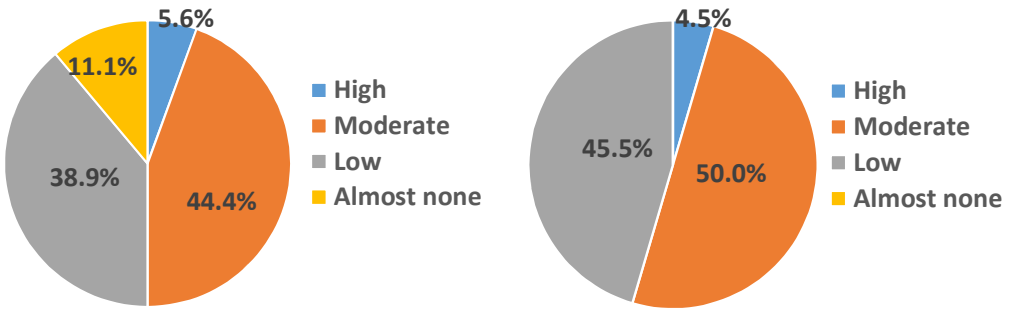
Besides of the recent achievements of the Urban Risk Reduction Program, other efforts have been placed on the improvement of building construction codes in Quito. Since 2001, a set of Architecture and Urbanism Standards has been approved, containing seismic provisions and earthquake resistant requirements for buildings (ANLAP 2005).

At the national level, the Ministry of Urban Development and Housing through the Agreement 0047 of January 10th of 2015 established the obligatory application of the Ecuadorian Code of Construction for all municipalities of the country (Official Register of Ecuador 2015).

[6] Descriptions of objectives regarding earth sciences and public awareness included in the Urban Risk Reduction Plan are presented in section 3.2.1. Also, strategies related with emergency response, preparedness and recovery are presented in section 3.6.2.

Figure 36 presents the scoring for community leaders and governmental institutions regarding the enforcement of earthquake resistant building construction codes. 50% of the participants of governmental institutions consider a moderate enforcement and 45 % scored low. Only 5% of the participants scored high.

Question: To your knowledge are earthquake resistant building construction codes enforced in your Parish?			
High	**Moderate**	**Low**	**Almost none**
Enforced for some cases	Enforced for a few cases	Not enforced	Codes do not exist



(a) Community leaders (b) Governmental institutions

Figure 36 Earthquake resistant building construction codes

3.5.3 Reinforcement and retrofitting of private infrastructure

According to the ordinance 0265 of 2008, private, natural and legal persons are equally responsible for their acts and omissions. They will be responsible for the consequences of the omission or lack of application of contingency plans and mitigation measures suggested by technical authorities.

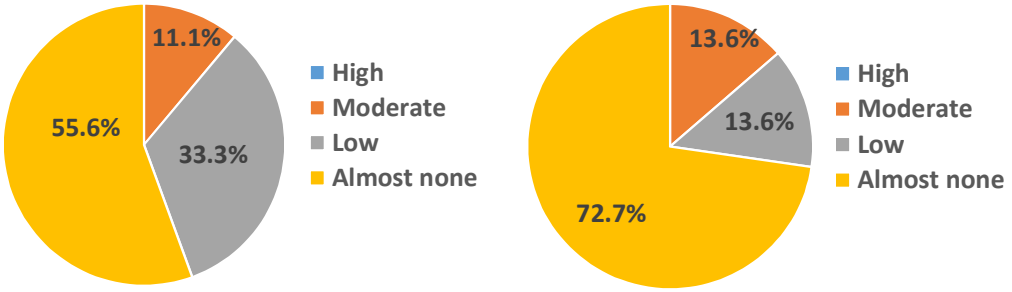
Regarding the vulnerability of the city, previous studies identified the fragility of buildings of the historical center (mainly adobe or unreinforced buildings) and informal constructions. In 2005, there were registered 5086 heritage buildings; most of them were built without any seismic provisions[7]. On the other hand, estimates show that approximately 30% of the housing units of Quito were built illicitly by low-income groups, without any seismic standard (ANLAP 2005).

Figure 37 delineates scoring of community leaders and governmental institutions regarding the reinforcement and retrofitting of private infrastructure. Most of the participants consider that such mitigation works are rarely carried out. In this sense, incentives could be promoted for the structural rehabilitation of buildings, as included in the program for the rehabilitation of facades and roofs of historical buildings.

Question: To what extent is the reinforcement and retrofitting of private infrastructure carried out (e.g. residences and private businesses)			
High	**Moderate**	**Low**	**Almost none**

[7] Scoring of participants regarding programs for the protection of the historical heritage are presented in 3.3.9.

Carried out for most private infrastructure	Carried out for some private infrastructure	Carried out for limited private infrastructure	Rarely carried out



(a) Community leaders (b) Governmental institutions

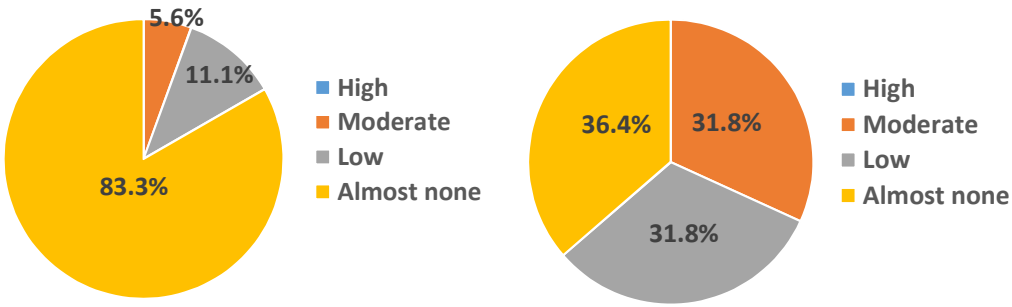
Figure 37 Reinforcement and retrofitting of private infrastructure

3.5.4 Availability and use of earthquake insurance

According to the head of the Chamber of Insurance Companies of Ecuador, families (households) don't have a culture of insurance of their properties regarding catastrophic events, even if the Horizontal Property Law establishes that every construction must be insured (El Comercio 2014 a). Figure 38 presents the scores for community leaders and governmental institutions regarding the availability and use of earthquake insurance. Most of the community leaders (83%) consider that no insurance is available or utilized. On the other hand, around 64% of the participants from governmental institutions scored between low to moderate.

Question: Is earthquake insurance available and utilized by residents and businesses?

High	Moderate	Low	Almost none
Extensive availability exists/utilized for most residences and businesses	Some availability exists/some utilization for residences and businesses	Limited availability exists	No insurance is available or utilized



(a) Community leaders (b) Governmental institutions

Figure 38 Availability and use of earthquake insurance

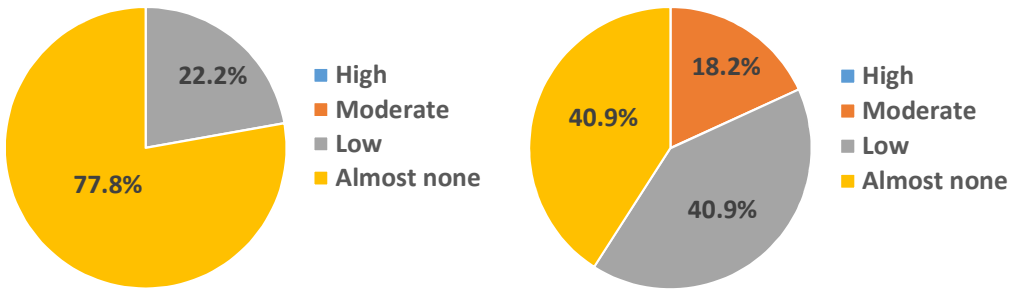
3.5.5 Availability of funding for disaster risk management plans or earthquake mitigation programs

For the Metropolitan District of Quito, the Metropolitan Fund for Risk Management and Emergency Attention (FMGR) was established through the ordinance 0265 of 2008. It is conformed by no less than 0.5% of the general annual budget of Quito and 5% of the income of the annual security tax. The Metropolitan Corporation of Citizen Safety administrates this fund. As a complement, each public institution of the government of Quito must include specific items in their budget for risk mitigation and emergency attention.

Figure 39 presents scores regarding the availability of funding for disaster risk management plans or earthquake mitigation programs.

Question: Are you aware of the availability of disaster risk management plans or earthquake mitigation funding that is available for your Parish?

High	Moderate	Low	Almost none
Extensive availability exists/utilized	Some availability exists/some utilization	Limited availability exists	No availability



(a) Community leaders (b) Governmental institutions

Figure 39 Availability of funding for disaster risk management plans or earthquake mitigation programs

From Figure 39 it is observable that a large percent of the representatives from the parishes consider that such funds are not available (78%); 22% scored low. On the other hand, 82% of the participants from public institutions scored between low to almost none. These results reflect the limitation of the public budget for promoting risk management activities. In this regard, efforts for finding additional sources (through international organization and cooperation) may be considered. Also, the criteria and procedures for prioritizing interventions could be reviewed and communicated to the population.

By using the evaluations from community leaders, an index of Planning, Regulation and Risk Mitigation was obtained for the parishes (see Figure 40). The average of the results of the governmental institutions was also included. In this case, participants from governmental institutions obtained a slightly more optimistic evaluation. Here, most of the scores provided by representatives from the communities varies between low (26%) to almost none (56%). This suggests that steps could be taken in order to improve the funds available for risk mitigation programs.

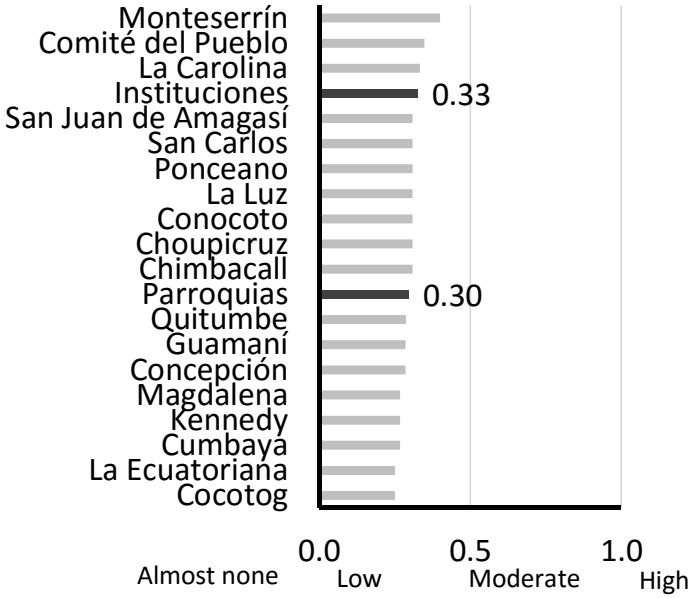


Figure 40 Planning, Regulation, and Mainstreaming Risk Mitigation. Summary of results by Parishes

3.6 Emergency Preparedness, Response, and Recovery

The objective of this theme is to identify the effectiveness and performance of the risk management system for response and recovery in the case of emergencies. This theme encompasses the preparation of the community, local centers, standard operational procedures and funds for emergency planning and response, and human and equipment available for emergency situations and plans for post-earthquake emergency operations. The status and current achievements as well the scores obtained during the workshop and presented in the following sections.

3.6.1 Current status and main achievements of the MSIRM regarding emergency preparedness, response and recovery

Within the Urban Risk Reduction Program, the following strategies are promoted for emergency preparedness, response and recovery:

- *Emergency planning:* promotes raising awareness programs for the population, as well as emergency plans and emergency drills for neighborhoods, communities and institutions and support the formation of communities, students and journalists

- *Emergency response:* oriented to the creation of an Integral System for the response to large-scale emergencies, the improvement of communication systems, pre hospital attention in case of disasters, training and formation of emergency workforces, rescue teams, development of municipal emergency and contingency plans, as well as teams of damage evaluation and building inspection in case of earthquakes.

- *Recovery:* includes the development of plans and strategies of reconstruction and recovery (such as housing and lifelines) including socioeconomic aspects, the identification of financial resources,

development of plans for reallocation of people affected and management of temporally shelters, updates of the cadastral database.

Table 10 presents projects and main achievements of the Urban Risk Reduction Program of Quito, regarding emergency preparedness, response and recovery (Jalil 2013).

Table 10 Projects developed for emergency preparedness Response and Recovery

Project	Description
Establishment of safe zones in case of earthquakes	On each Zonal Administration evacuation areas were defined according to population density and services and equipment required.
Campaigns for public information and formation within schools	Campaigns oriented to the general population of the MDQ regarding earthquake risk; campaigns oriented to the school sector (both students and teachers) in order to inform about earthquakes and preparation of emergency plans for schools.
Improvement of the systems of emergency response	Improvement of the Center of Medical Assessment of the Civil Aviation; definition of protocols for emergencies and contingencies for medical attention; Improvement of the pre-hospital and emergency attention; strengthening of the Center of Operations for Emergencies.
District system of communications for emergencies	Design of a system for communications in case of disaster. Definition of protocols for official communications before and after the occurrence of emergencies.

Source (Jalil 2013)

Main achievements (Jalil 2013):

- Development of an Emergency Plan for the MDQ.
- Development of contingency plans for each Zonal Administration; clear roles assigned to public authorities.
- Protocols for response and communication when facing emergencies and disasters.
- Improvements of facilities for emergency management and Emergency Operation Centers.
- 3 guidelines: citizen safety, risk management and road safety. Application in two sectors at the north and south of Quito: Santa Maria and Eloy Alfaro. Conformation of neighborhood safety committees and emergency plans. Participation of NGO's in the process.
- 400 drills developed in schools, 100 in neighborhoods and 1 per zonal administration.

Regarding the Emergency Plan for Quito, the following aspects have been defined (Proaño-Castro 2012):

- An organizational scheme, lineaments, policies and criteria for emergency attention.
- Types and levels of emergencies, alerts and response procedures.
- Structure and protocols for the activation of Emergency Operation Centers (metropolitan, by zonal administrations).
- Financial and administrative procedures.
- Roles and procedures for the coordination of emergencies.
- Roles of the Unified Command and activities by levels of alert.
- Operation of the system of emergency calls.
- Functions of the task forces (firemen, Red Cross, national and metropolitan police, health facilities); functions of the administrative authorities, public services and lifelines.
- Aid management and international cooperation.
- Damage assessment and public information.
- Updating procedures of the Emergency Plan.
- Through the administrative ordinance No 036-CG-CBDMQ-2009 a template for the development of Emergency Plans for commercial and industrial, administrative and educational facilities was approved.
- A detailed description of critical facilities of the city (D'Ercole 2003).

For emergency attention and recovery, the following policies were established (Proaño-Castro 2012):

- Economic resources required in emergency situations will be obtained through the Metropolitan Fund for Risk Management.
- Emergencies should be managed first at the local level. According to the damages and needs, the emergency could be managed at the level of Zonal Administrations, the Metropolitan District and the Nation.
- The criteria for emergency attention encompasses (i) protection of human life and basic needs of affected population; (ii) protection of infrastructure and services; (iii) prevention of environmental damages; (iv) control of secondary effects of events; (v) rehabilitation of basic services (lifelines) and (vi) reactivation educational services and main economic activities.

Regarding the function of public services and emergency situations, the following working groups have been defined for contingency plans in Quito:

Working group	Mission
Access and distribution of drinking water and sanitation services	Guarantee the opportune and sufficient provision of drinking water and sanitation services. It includes activities such as the quality control of drinking water, identify drinking water needs on critical services surveillance, transportation and distribution of water, among others.
Promotion of health and hygiene	Guarantee the continuity and quality of health and hygiene services for the population. It includes activities such as disease control, medical assistance to affected population, among others.
Infrastructure and rehabilitation	Perform opportune preventive works to reduce risks in the infrastructure; rehabilitation and reconstruction of affected infrastructure. It includes activities such as debris management and rehabilitation of services.
Integral assistance to the population	Guarantee the well-being of the affected population. It includes activities such as the provision/distribution of humanitarian aid, management of temporary shelters, provide emotional and psychological support, among others.
Integral safety of the population	Guarantee the safety of the population, properties and infrastructure of basic services. It includes activities such as surveillance, public order, fire suppression, evacuation and transportation of population, among others.
Productivity and livelihoods	Risk reduction of productive sectors. It includes activities such as the identification of vulnerabilities of productive sectors, development of recovery plans, support of insurance programs and storage of goods.
Education, culture and environment	Strengthening of a preventive culture and risk reduction in schools. It includes activities such as alternative facilities for schools, definition of specific educational programs for affected population, coordination of educational and cultural activities for affected population, activities for the protection and recovery of cultural heritage, among others
Strategic infrastructure for development	Reduce the risk of strategic infrastructure of the city. It included activities such as the development of a database of the strategic infrastructure, plans of risk reduction and business continuity

3.6.2 Population storing goods to be used in case of disasters

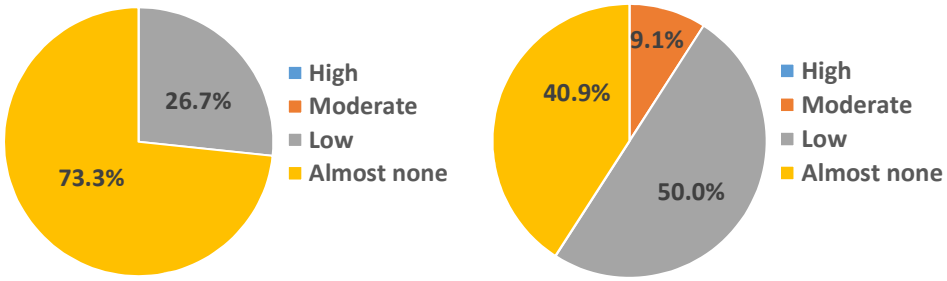
Aside from the information and bulletins developed by the MSIRM, the Institute of Geophysics of Ecuador presents a set of recommendations for population before and after disasters, including suggestions for the minimal contents of a personal emergency preparedness kit.[8]. Figure 41 presents the scores drafted from the responses of community leaders and governmental institutions regarding population storing of goods to be used in case of disasters. Around 73% of the community leaders consider that almost none of the population stores goods to be used in case of disasters. Around 50% of

[8] See: http://www.igepn.edu.ec/que-hacer-ante/un-sismo [Last checked 31/12/2015]

the participants from governmental institutions consider that few people store goods and 40% consider that almost none.

Question: To your knowledge, do people in your Parish store food, water and fuel that will be available for more than one week following an earthquake?

High	Moderate	Low	Almost none
Most	Some	Few	Almost None



(a) Community leaders (b) Governmental institutions

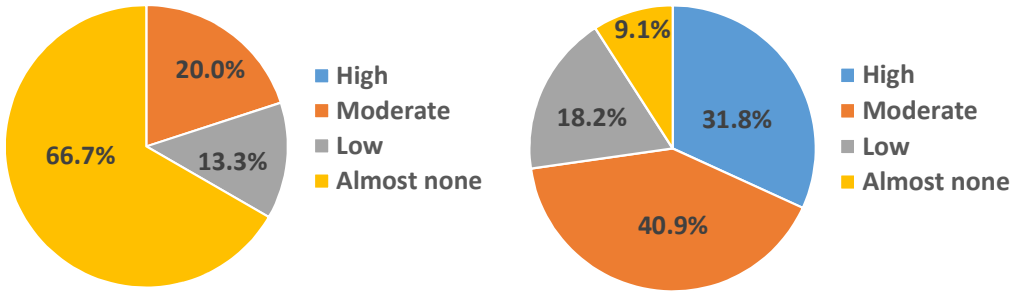
Figure 41 Population storing goods to be used in case of disasters

3.6.3 Local centers for implementing and coordinating emergency response and management

A metropolitan Center for Emergency Operations has been established in the ordinance 0265 of 2008, describing its functions and participants. Also, within the Urban Risk Reduction Program such centers are promoted within the Zonal Administrations. Figure 42 presents the scoring of community leaders and governmental institutions regarding local centers for implementing and coordinating emergency response and management.

Question: Is available in your Parish a local center for implementing and coordinating emergency response and management?

High	Moderate	Low	Almost none
Available and fully operational	Available but partially operational	Available but not operational	Not available



(a) Community leaders (b) Governmental institutions

Figure 42 Local centers for implementing and coordinating emergency response and management

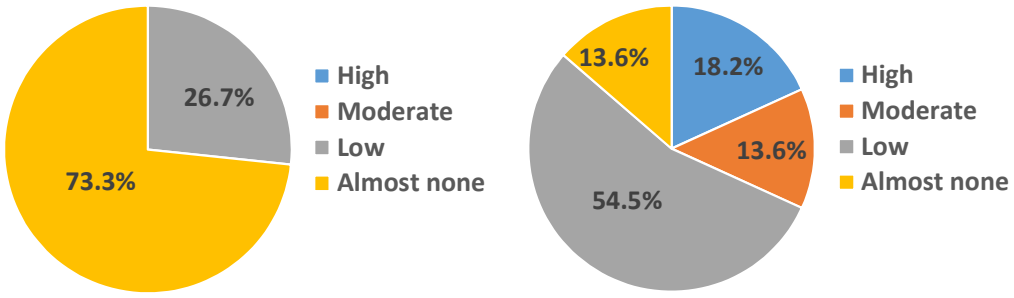
Diverging scores were obtained on this topic. While 66% of the community leaders consider that there are no such centers available, around 31% of the participants from public institutions consider them fully operational and 40% partially operational. Given the efforts of the municipality in improving facilities for emergency planning, care can be taken to inform the community about their existence and their protocols.

3.6.4 Standard operational procedures for coordinating emergency rescue and response activities

Figure 43 pertains to the scoring regarding the presence and use of standard operational procedures for coordinating emergency, rescue and response activities. As found in the previous topic, there are differences in the scores of community leaders and governmental institutions. 73% of the community leaders consider that there are no operational procedures. On the other hand, 18% of the representatives from public institutions consider that there are well-defined procedures and 54% considered that those are limited for some units.

Question: Are there standard operational procedures (SOP) that include communication plans for coordinating emergency rescue and response activities of relevant units in your Parish (e.g. Emergency Command System)?

High	Moderate	Low	Almost none
Well defined procedures, and fully functional for all relevant units	Basic procedures, with limited functionality for all relevant units	Limited procedures for some units	No operational procedures



(a) Community leaders (b) Governmental institutions

Figure 43 Standard operational procedures for coordinating emergency rescue and response activities

3.6.5 Funds for emergency preparedness, response and recovery operations

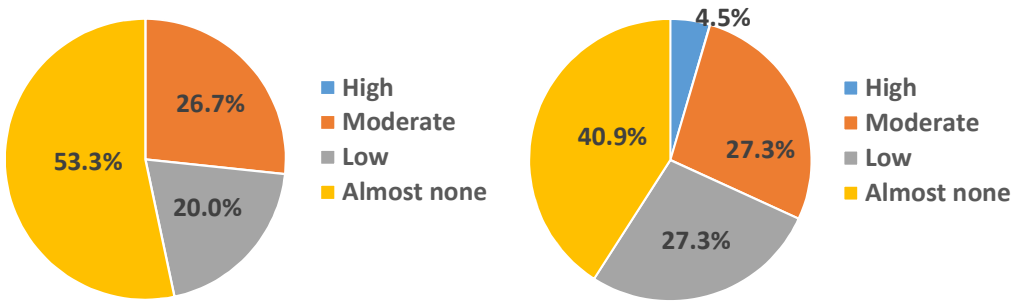
As previously discussed, the city has a Fund for Risk Management and Emergency attention. A regulation on the use of such a fund has been also established. At maximum, 40% of the fund will be available for activities of prevention and mitigation and 60% will be available for emergency response. Resources not used in a given year, could be available for the next periods.

For a given emergency, if the resources required are greater than 10,000 USD, a declaration of emergency is required by the major and the Secretariat of Safety and Governance. In this case, such resolution will be published as well as a report describing the use of such resources.

Figure 44 presents the scoring for community leaders and governmental institutions regarding funds for emergency preparedness, response and recovery operations. Many of the community leaders and the governmental institutions (more than 40% of the participants) consider that such funds are not enough or are not available. Near the 27% consider that those are available but with legal restrictions and special requirements.

Question: Are funds available for emergency preparedness, response and recovery operations?

High	Moderate	Low	Almost none
Funds are directly available and can be used at the Parish's discretion	Funds are available but with legal restrictions and special requirements	Funds are planned for but are not available	Funds are not available



(a) Community leaders (b) Governmental institutions

Figure 44 Funds for emergency preparedness, response and recovery operations

3.6.6 Human resources for emergency preparedness, response and recovery operations

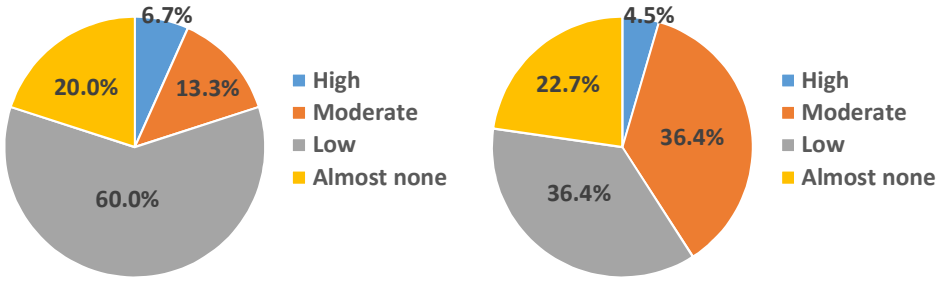
The Provincial Directorate of Health of Pichincha and the Health Secretariat of Quito coordinate the health services in Quito. Health services are provided by hospitals, clinics, centers, sub centers, health posts, and dispensaries, family planning centers, among others. The total of health facilities in Quito was 468 for 2010. The percentage of public beds to the total is around 60%. (Secretaria Metropolitana de Salud 2015), and there are approximately 30 beds available for every 10,000 inhabitants (ANLAP 2005).

For 2010, the total personal for medical attention was around 23,143, (13,707 from public and 9,436 from private institutions). It represents a rate of 10.3 persons of medical attention per 1000 inhabitants. Regarding task forces, there is fire brigade with 19 fire stations for the Metropolitan district, Red Cross facilities and personnel, as well as the participation of the national and metropolitan police.

Figure 45 renders the scoring regarding human resources for emergency preparedness, response and recovery operations. Results shows that many of the community leaders (around 60%) consider that there are insufficient human resources and 20% scored almost none. On the other hand, 36% of the participants from public institutions scored moderate, 36% low and 22% almost none.

Question: Are human resources that are coordinated and trained available for emergency preparedness, response and recovery operations (including volunteers and/or community organizations)?

High	Moderate	Low	Almost none
Many human resources available	Some human resources available	Limited human resources available	Insufficient human available



(a) Community leaders (b) Governmental institutions

Figure 45 Human resources for emergency preparedness, response and recovery operations

3.6.7 Equipment for emergency rescue, response, and cleanup operations

A rough inventory of resources available for the Metropolitan District of Quito for emergency attention and recovery is described in Proaño-Castro (2012). A summary of this inventory is presented below:

- *Ambulances*: 19 ambulances; 12 of the fire brigade; 3 of the Red Cross; 2 from the National Police and 2 From the Provincial Council of Pichincha.
- *Safe Places*: a safe place is a location within the city, intended to protect citizens during and after an earthquake event. 30 Safe Places were established and distributed along the MDQ with a capacity of 713,420 persons.
- *Shelters*: 42 shelters were distributed and fitted along the MDQ, with a capacity of 2,876 persons (see Table 11).
- *Machinery*: For 2012, the inventory of any machinery for emergency response was around 2000 units. 24% belongs to the public sector (Army, Provincial Council, cleaning services) and 76% to the private sector.
- *Sources of materials and construction goods*: Approximately 117 business sell construction goods. Quarries providing stone, sand and clay are also important for recovery works. Those are located at the north and the east, in the Parishes San Antonio, Guayllabamba, Calderón, Nayton and Ecuatoriana.

Table 11 Shelters in the Metropolitan District of Quito

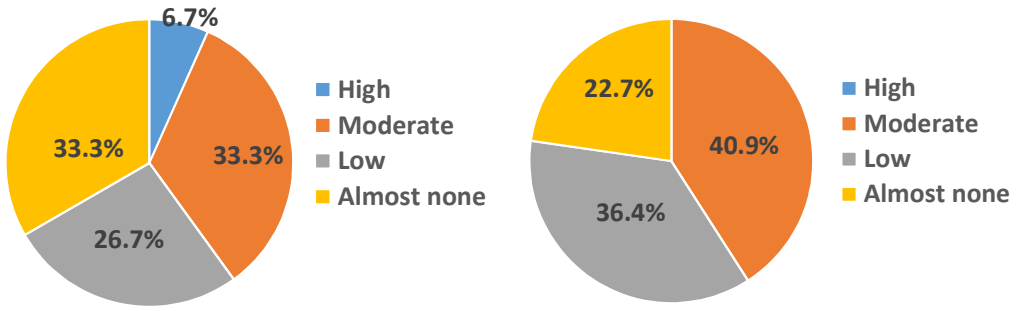
Zonal Administration	Number of shelters	Capacity (persons)
Calderon	5	155
La Delicia	9	606
Eugenio Espejo	6	145
Manuela Saenz	3	95
Eloy Alfaro	6	195
Quitumbe	4	400
Tumbaco	4	390
Los Chillos	5	890
Total	42	2876

Source (Jalil 2013)

Figure 46 presents scoring of community leaders and governmental institutions regarding equipment for emergency rescue, response, and cleanup operations. Around 23% of the participants from public institutions consider that no equipment exists that is readily available; 36% consider it low and around 41% consider it moderate.

Question: Is equipment readily available that can be used for prompt and effective emergency rescue, response, and cleanup operations?

High	Moderate	Low	Almost none
Many equipment types exist that are readily available	Some equipment types exist that are readily available	Some equipment types exist but they are not readily available	No equipment exists that is readily available



(a) Community leaders (b) Governmental institutions

Figure 46 Equipment for emergency rescue, response, and cleanup operations

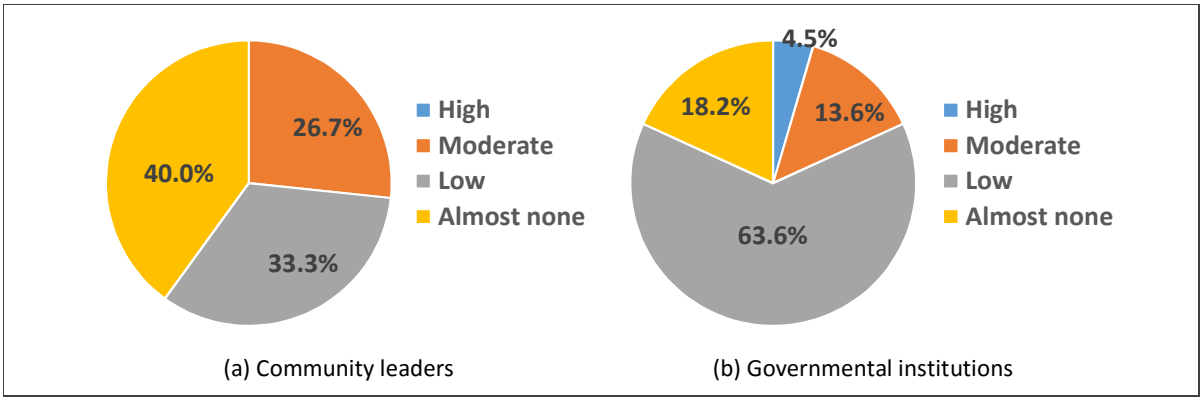
3.6.8 Response plan for post-earthquake emergency operations

This sub-section presents results about response plans for post earthquake recovery of the following sectors: (i) access and distribution of drinking water and sanitation services; (ii) promotion of health and hygiene; (iii) infrastructure and rehabilitation; (iv) integral assistance to the population; (v) Integral safety of the population; (vi) productivity and livelihoods; (vil) Education, culture and environment and (viii) Strategic infrastructure for development. Such sectors are considered by the Metropolitan System of Risk Management of Quito for the development of contingency plans.

(i) Health and sanitation: From Figure 47, around 64% of the participants from governmental institutions consider that such plans are not implemented and 18% consider that those does not exist. Given that a larger proportion of community leaders consider that such plans does not exist, it may be beneficial to promote programs for information about plans for health and sanitation.

Question: Is there a response plan for post-earthquake emergency operations available for health and sanitation services?

High	Moderate	Low	Almost none
Plan exists, implemented, and regularly updated	Plan exists and implemented	Plan exists but not implemented	No plan exists



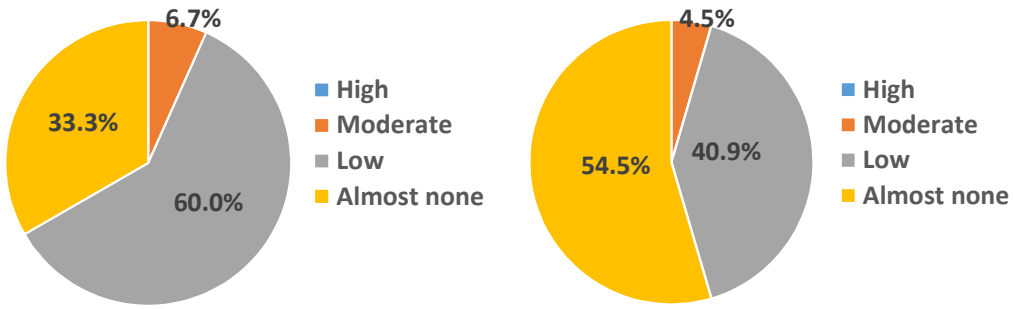
(a) Community leaders (b) Governmental institutions

Figure 47 Response plan for post-earthquake emergency operations for health and sanitation services

(ii) Health and hygiene: Figure 48 presents the scores of community leaders and governmental institutions regarding plans for health and hygiene in case of earthquake situations. 55% of the participants from public institutions consider that no plan exists; and 41% scored low.

Question: Is there a response plan for post-earthquake emergency operations available for health and hygiene

High	Moderate	Low	Almost none
Plan exists, implemented, and regularly updated	Plan exists and implemented	Plan exists but not implemented	No plan exists



(a) Community leaders (b) Governmental institutions

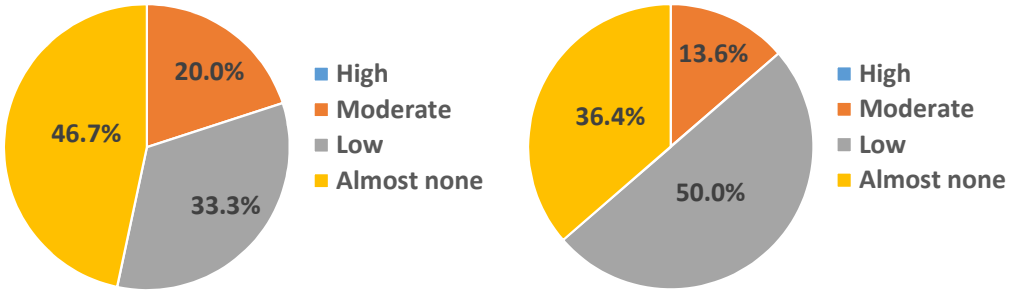
Figure 48 Response plan for post-earthquake emergency operations for health and hygiene

(iii) Integral assistance to the population: In case of emergencies, both the national and the local governments have activated Centers of Emergency Operations for the assistance of population. Recently, in response to the earthquake of Quito on August 12 of 2014, the Ministry of Public Health and Social and Economic Inclusion, as well as the National Secretariat of Risks, the National Police and the Army coordinated the provision of shelter, humanitarian assistance and psychological support to the affected population (El Ciudadano 2014).

Figure 49 presents the scores of community leaders and governmental institutions regards plans for integral assistance for the population. Around 36% of the participants from public institutions consider that no plan exists; 50% scored low and around 13% scored moderate.

Question: Is there a response plan for post-earthquake emergency operations available for integral assistance to the population

High	Moderate	Low	Almost none
Plan exists, implemented, and regularly updated	Plan exists and implemented	Plan exists but not implemented	No plan exists



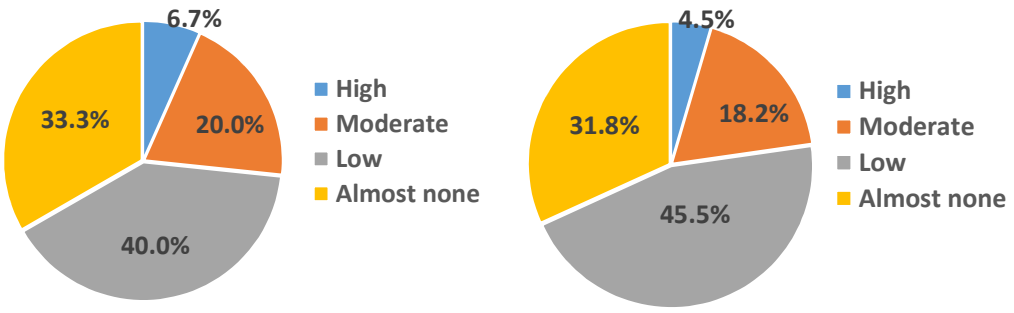
(a) Community leaders (b) Governmental institutions

Figure 49 Response plan for post-earthquake emergency operations for integral assistance to the population

(iv) Integral safety of the population: Figure 50 shows similar results for community leaders and public institutions. Near 30% of the participants consider that no plans exist; around 40% scored low and around 20% scored moderate.

Question: Is there a response plan for post-earthquake emergency operations available for integral safety of the population

High	Moderate	Low	Almost none
Plan exists, implemented, and regularly updated	Plan exists and implemented	Plan exists but not implemented	No plan exists



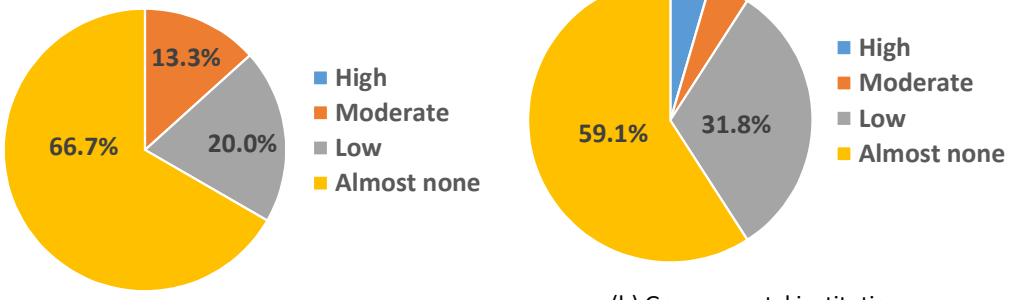
(a) Community leaders (b) Governmental institutions

Figure 50 Response plan for post-earthquake emergency operations for integral safety of the population

(v) Infrastructure and rehabilitation: Figure 51 shows that around 60% of the participants from public institutions consider that no plans exist; 30% scored low. Similar proportions were found for community leaders.

Question: Is there a response plan for post-earthquake emergency operations available for infrastructure and rehabilitation

High	Moderate	Low	Almost none
Plan exists, implemented, and regularly updated	Plan exists and implemented	Plan exists but not implemented	No plan exists



(a) Community leaders

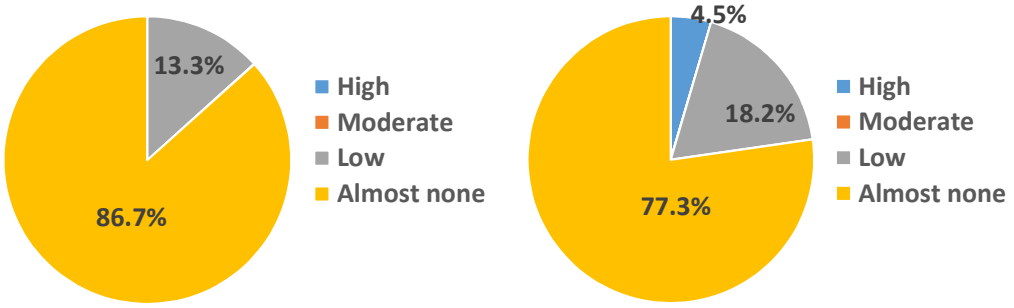
(b) Governmental institutions

Figure 51 Response plan for post-earthquake emergency operations for infrastructure and rehabilitation

(vi) Productivity and livelihoods: Figure 52 shows that around the 80% of the participants consider that no plan exists. More than 13% consider that those plans exist but are not implemented.

Question: Is there a response plan for post-earthquake emergency operations available for productivity and livelihoods?

High	Moderate	Low	Almost none
Plan exists, implemented, and regularly updated	Plan exists and implemented	Plan exists but not implemented	No plan exists



(a) Community leaders

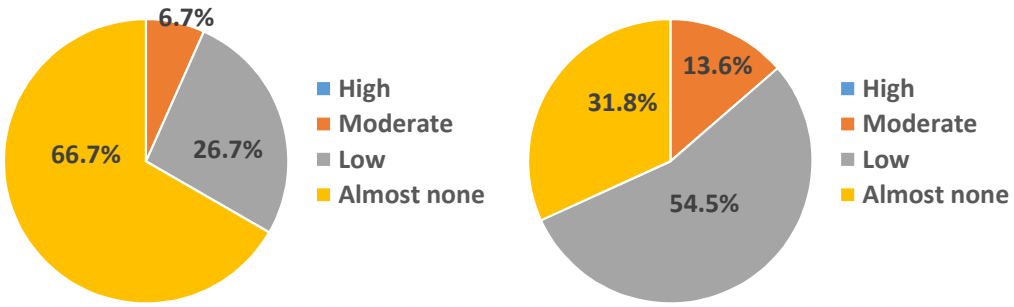
(b) Governmental institutions

Figure 52 Response plan for post-earthquake emergency operations for productivity and livelihoods

(vii) Education, culture and environment Figure 53 shows that around 30% of the participants from public institutions consider that no plan exists; more than 50% scored low and 13% scored moderate.

Question: Is there a response plan for post-earthquake emergency operations available for education, culture and environment?

High	Moderate	Low	Almost none
Plan exists, implemented, and regularly updated	Plan exists and implemented	Plan exists but not implemented	No plan exists



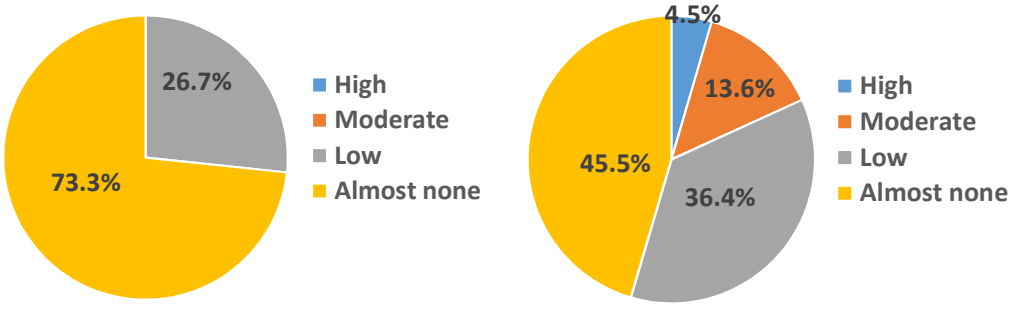
(a) Community leaders (b) Governmental institutions

Figure 53 Response plan for post-earthquake emergency operations for education, culture and environment

(viii) Strategic infrastructure for development: Figure 54 shows that 45% of the participants from public institutions consider that no plan exists; 36% scored low and 13% scored moderate. The majority of the participants from communities (73%) scored almost none.

Question: Is there a response plan for post-earthquake emergency operations available for education, culture and environment?

High	Moderate	Low	Almost none
Plan exists, implemented, and regularly updated	Plan exists and implemented	Plan exists but not implemented	No plan exists



(a) Community leaders (b) Governmental institutions

Figure 54 Response plan for post-earthquake emergency operations for strategic infrastructure for development

By using the evaluations from community leaders, an index for Emergency Preparedness, Response and Recovery was developed (see Figure 55) and includes the average of the results of the governmental institutions for comparison.

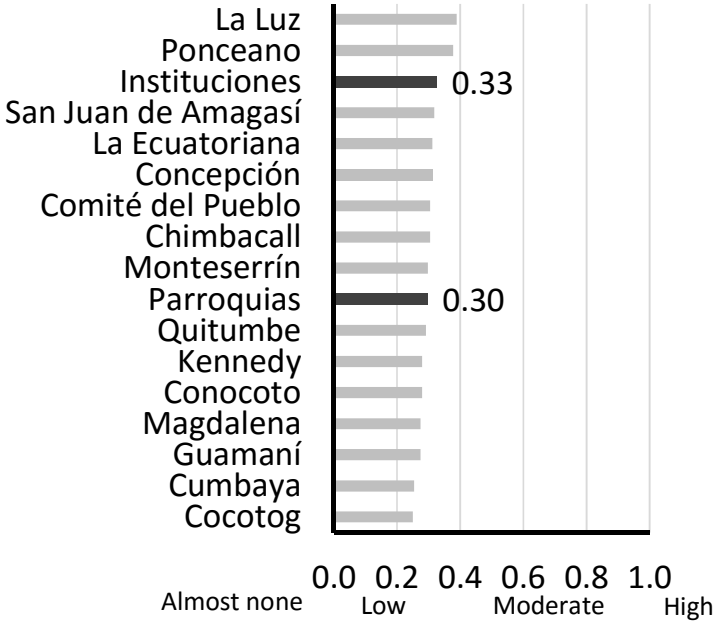


Figure 55 Emergency preparedness response and recovery: summary of results by Parish

A slightly more optimistic evaluation was obtained via participants from governmental institutions, in particular regarding topics related to response plans for post-earthquake operations and standard operational procedures for coordinating emergency response. Most of the scores provided by representatives from the communities vary between almost none (55%) to low (31%). Efforts could be intensified in order to implement emergency and contingency plans, to continue the development of simulation and drills and evaluate the required the resources (personal and equipment) in case of earthquake events.

3.7 Critical Services and Public Infrastructure Resilience

The objective of this theme is to identify the resilience of critical services in case of emergency. This theme encompasses the assessment, reinforcement and reduction of structural and non-structural vulnerabilities of critical public infrastructure and lifelines, as well as the development business continuity plans and plans to repair damaged structures. The status and current achievements in such topics, as well the scores obtained during the workshop are presented in the following sections.

3.7.1 Assessment, reinforcement, and retrofitting of critical public infrastructure such as schools and hospitals

Vulnerability assessment and risk mitigation in schools

In 1995 the Project of Seismic Safety of Educational Facilities in Quito was promoted (GeoHazards International 1995). Within this project a prioritization scheme was conducted in order to evaluate the vulnerability of schools. First, a sample of facilities of high density of students per built area was selected. Then, 340 buildings have been inspected and vulnerability calculations have been obtained following the rapid visual screening method (ATC 1988). Finally, for the most vulnerable buildings

detailed structural analysis were performed. During this analysis 15 buildings have been classified as high risk and retrofitting schemes have established (Fernández et al. 1996).

Within the Project of Assessment of Vulnerabilities and Disaster Risk Reduction at the municipal scale in Ecuador, supported by the United Nations Development Program (UNDP) the seismic retrofitting of 6 schools of vulnerable areas of Quito was promoted, as well as the strengthening of educational community capacities (Jalil 2013).

Also, in the Urban Risk Reduction Program of Quito, a project for the physical vulnerability of essential facilities in the city was considered. Such project encompasses studies in schools, hospitals, fire stations and public administrative buildings. The objective was to obtain architectural and structural plans of the mitigation works as well as retrofitting costs.

In 2011 the Metropolitan District of Quito promoted a vulnerability assessment of 36 educational facilities. From this study 34% have been considered as highly vulnerable, 36% vulnerable and 30% safe. Based on such results retrofitting designs has been conducted. These studies have demonstrated that the costs of retrofitting works are around 15% of the total cost of the structures (El Comercio 2014 b). As an example, the cost of the rehabilitation of one important school of Quito "Colegio Mejía" was around 3.56 million USD. Such intervention encompasses, besides of the retrofitting works, architectural updates and improvements of the systems of communication, electricity and sewage (El Telégrafo 2015).

Risk mitigation in hospitals

The risk mitigation of health facilities has been promoted in Quito. In 1996 the seismic safety of hospitals in the city was analyzed in order to identify the seismic demand and present a methodology for the vulnerability assessment of hospitals in the city (Qachet-Giacometti &. Fernández 1996). For 2005, the vulnerability assessment of 8 major hospitals in Quito was completed (ANLAP 2005).

Analysis and inventories of essential places/facilities in Quito

D'Ercole & Metzger (2002) presented an analysis of essential places of Quito, describing the location and type and characteristics of the services provided by educational, health and recreational facilities, as well as buildings and places of heritage and culture. Also a description of the components and characteristics of the operation of lifelines (water and sanitation, food supply, electricity, fuel, telecommunications, transportation) and main economic sectors and industries was presented. In addition, the location and relevance of national and local governmental institutions is also described.

Figure 56 presents the scoring of community leaders and governmental institutions regarding the assessment, reinforcement, and retrofitting of critical public infrastructure such as schools and hospitals. Many of the community leaders and the governmental institutions (more than 40% of the participants) consider that such mitigation works have not been performed.

Question: To what extent is the assessment, reinforcement, and retrofitting of critical public infrastructure such as schools and hospitals carried out?			
High	**Moderate**	**Low**	**Almost none**
Carried out for most critical public infrastructure	Carried out for some critical public infrastructure	Carried out for few critical public infrastructure	Not carried out

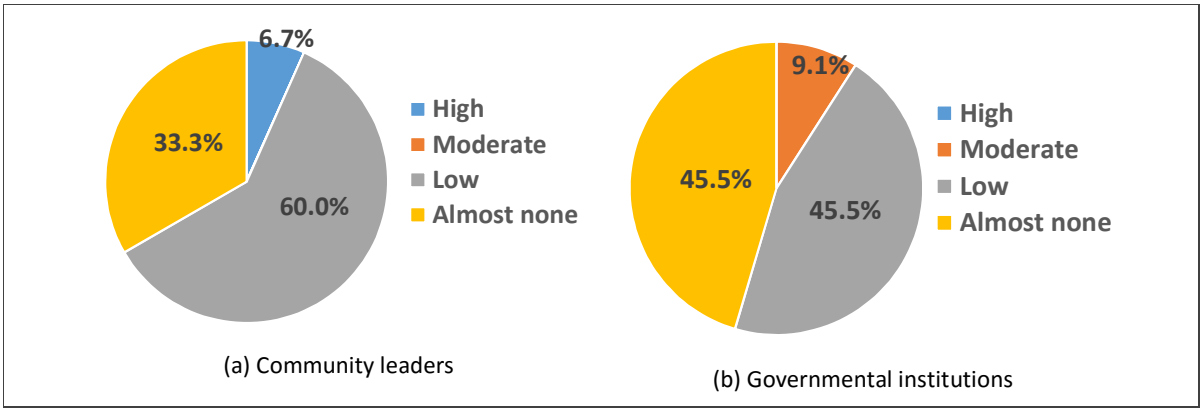


Figure 56 Assessment, reinforcement, and retrofitting of critical public infrastructure

3.7.2 Incorporation of non-structural improvements to reduce seismic risk to make critical facilities more resilient

Health facilities

Mena & Serrano (2002) present an analysis of the geographical distribution of health facilities and the type of services provided. The authors also present a methodology for vulnerability assessment including structural, non structural and administrative aspects. This methodology has been applied for a group of 25 hospitals and could be used for identifying key aspects for reducing the functional vulnerability of such facilities.

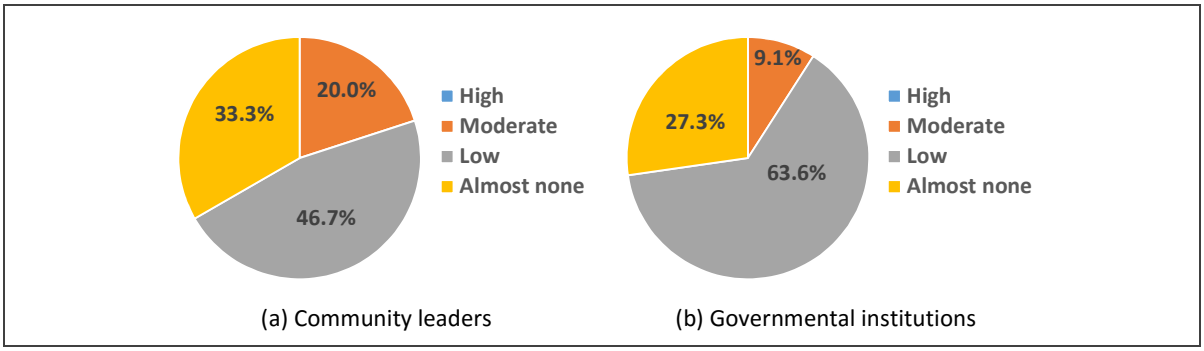
In addition, in D´Ercole & Metzger (2004), an analysis of the accessibility to health facilities has been performed, considering indices for traffic congestion, quality of road connections, road conditions and access to buildings. The findings show that most of the hospitals have a limited accessibility, mainly due to traffic congestion.

At the national level, according to the monitoring report of the Hyogo Framework for Action of 213 (Cornejo 2015), all hospitals in Ecuador fulfill the policies and safety standards defined by the Panamerican Health Organization since 2008.

Figure 57 presents scores from community leaders and governmental institutions regarding the incorporation of non-structural improvements to reduce seismic risk to make health facilities more resilient. Many of the participants (>60%) from governmental institutions consider that such mitigation works have occurred in a few hospitals. In this regard, the strategy of hospitals safe from disasters could be promoted.

Question: To your knowledge are specific non-structural improvements to reduce seismic risk incorporated to make health facilities more resilient (e.g. tying down or relocating essential equipment)?

High	Moderate	Low	Almost none
Have occurred in most health facilities	Have occurred in some health facilities	Have occurred in a few exceptional health facilities	Have not occurred



(a) Community leaders (b) Governmental institutions

Figure 57 Incorporation of non-structural improvements to reduce seismic risk to make health facilities more resilient

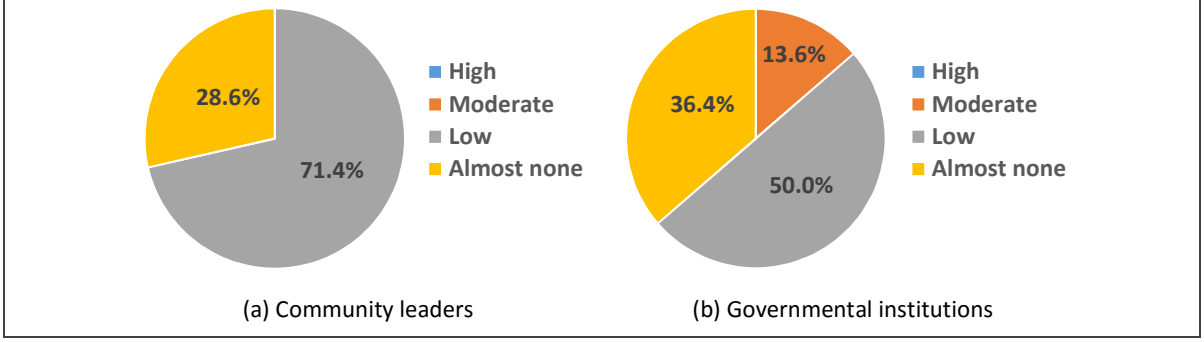
Educational facilities

Within the Project "Assessment of vulnerabilities and disaster risk reduction at the municipal scale in Ecuador" a methodology was adopted that is promoted by the International Red Cross for the assessment of vulnerabilities and capacities of educational facilities. Such methodology has been validated in six schools of Quito, with the participation of teachers, students and their relatives. Given the importance of this analysis, its application has been extended for other cities in Ecuador and a simplified method has been considered in order to evaluate a set of 1,200 schools in Quito within the project "My school is being prepared" (Jalil 2013).

Figure 58 presents the scoring that pertains to the incorporation of non-structural improvements to reduce seismic risk to make educational facilities more resilient. 50% of the participants from public institutions consider a low implementation of such mitigation works; 36% scored almost none and 13% scored moderate. In this regard, it is considered relevant to promote the assessment of vulnerabilities of educational facilities and promote non structural interventions within national and local programs.

Question: To your knowledge are specific non-structural improvements to reduce seismic risk incorporated to make educational facilities more resilient (e.g. tying down or relocating essential equipment)?

High	Moderate	Low	Almost none
Have occurred in most educational facilities	Have occurred in some educational facilities	Have occurred in a few exceptional educational facilities	Have not occurred



(a) Community leaders (b) Governmental institutions

Figure 58 Incorporation of non-structural improvements to reduce seismic to make educational facilities more resilient

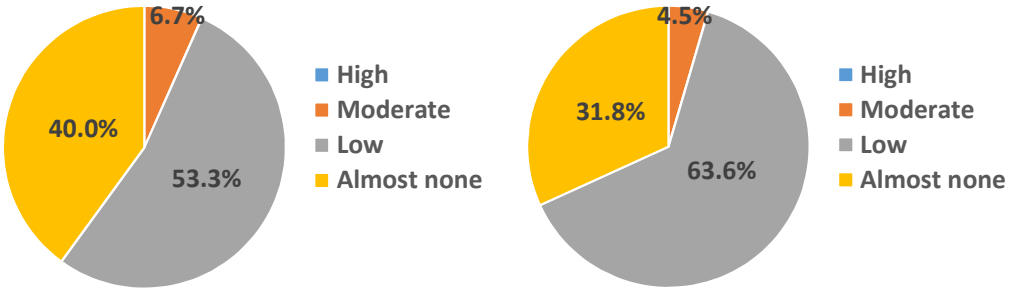
3.7.3 Structural improvements to reduce seismic risk in lifelines

D´Ercole & Metzger (2004) presents a vulnerability assessment of the electric power and water and sanitation systems taking into account qualitative indices for describing the fragility of the components (considering failure rates and deterioration) as well as their dependency to other external systems and components, backup systems, control capacity and emergency response capacity. In addition, a seismic vulnerability and a probabilistic risk assessment of the water and sanitation system in Quito were promoted within the Urban Risk Reduction Program. The study was considered useful in order to identify critical components and potential damages of the system (EPMAPS 2013).

Figure 59 presents scores of community leaders and governmental institutions regards the incorporation of structural improvements to reduce seismic risk in lifelines. Most of the participants from public institutions (63%) consider a low implementation of such mitigation works; 31% scored low and 13% scored moderate. In this sense, projects oriented to the assessment and reduction of earthquake risk of lifelines could be promoted.

Question: To your knowledge are specific structural improvements to reduce seismic risk in lifelines incorporated (e.g. water, electricity, bridges, roads)?

High	Moderate	Low	Almost none
Have occurred for most lifelines	Have occurred for many lifelines	Have occurred for a few exceptional cases	Have not occurred



(a) Community leaders (b) Governmental institutions

Figure 59 Structural improvements to reduce seismic risk in lifelines

3.7.4 Business continuity plan of local governmental offices for the aftermath of a damaging earthquake

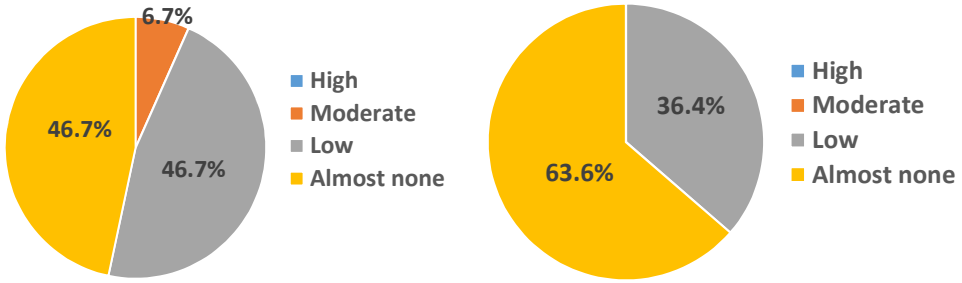
Business continuity plans are required for the development of the Emergency Plan of Quito in order to guarantee the availability and functionality of facilities and services provided by government and public institutions (Proaño 2012). Some private companies of mobile communications have developed such type of plans in order to face the high demand of services in case of catastrophe (El Comercio 2014 c).

Figure 60 is a delineation of the scores of community leaders and governmental institutions regarding the development and implementation of business continuity plans of local governmental. Most of the participants from public institutions (63%) consider that no plan exists; around 36% scored low. In this regard, the MSIRM should address efforts in the definition and implementation of business continuity

plans for the public services of the city, as well as the promotion of simulation and drills in order to review and adjust such plans.

Question: Do your Parish offices have a business continuity plan for the aftermath of a damaging earthquake

High	Moderate	Low	Almost none
Plan exists, implemented, and regularly updated	Plan exists and implemented	Plan exists but not implemented	No plan exists



(a) Community leaders (b) Governmental institutions

Figure 60 Business continuity plan of local governmental offices for the aftermath of a damaging earthquake

3.7.5 Plans for the repair or replacement of critical lifelines in the aftermath of a damaging earthquake event

Figure 61 presents scores from community leaders and governmental institutions regarding plans for the repair or replacement of critical lifelines in the aftermath of earthquakes. Most of the participants from public institutions (68%) consider that no plan exists; 27% scored low and 4.5% scored moderate. In this regard, the MSIRM should address efforts in the definition and implementation of recovery activities of public systems and lifelines in contingency plans.

Question: Does your Parish have a plan for the repair or replacement of critical lifelines in the aftermath of a damaging earthquake event (e.g. water, electricity, telephone)?

High	Moderate	Low	Almost none
Plan exists, implemented, and regularly updated	Plan exists and implemented	Plan exists but not implemented	No plan exists

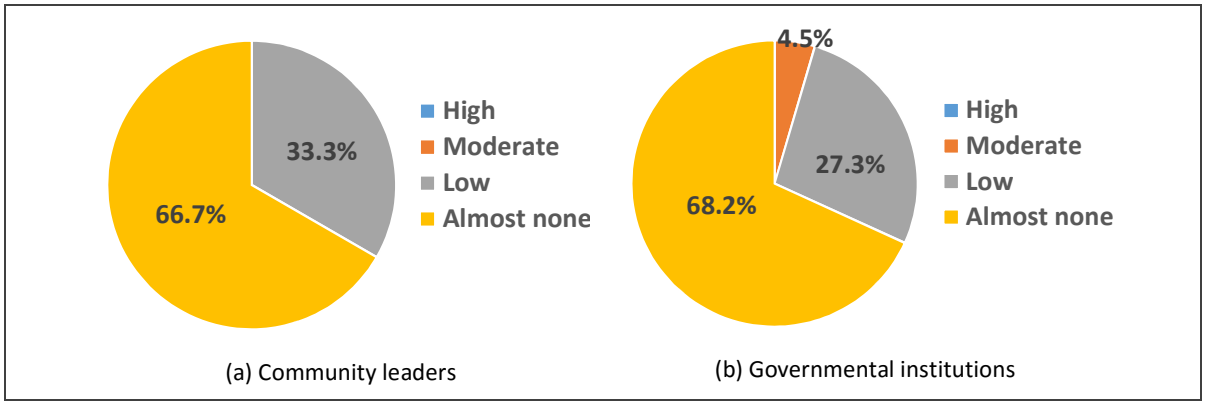


Figure 61 Plans for the repair or replacement of critical lifelines in the aftermath of a damaging earthquake event

By using the evaluations from community leaders, an index for Emergency Preparedness, Response and Recovery was developed at the Parish level (see Figure 62) that also considers the average of the results of the governmental institutions.

A slightly more optimistic evaluation was obtained by participants from governmental institutions, in particular in topics related to the assessment, reinforcement, and retrofitting of critical public infrastructure such as schools and hospitals. Most of the scores provided by representatives of the communities vary between almost none (38%) to low (56%). Efforts could be intensified in order to promote projects for the structural and non-structural vulnerability of essential facilities and lifelines, and to implement plans for business continuity and recovery of lifelines in case of earthquake events.

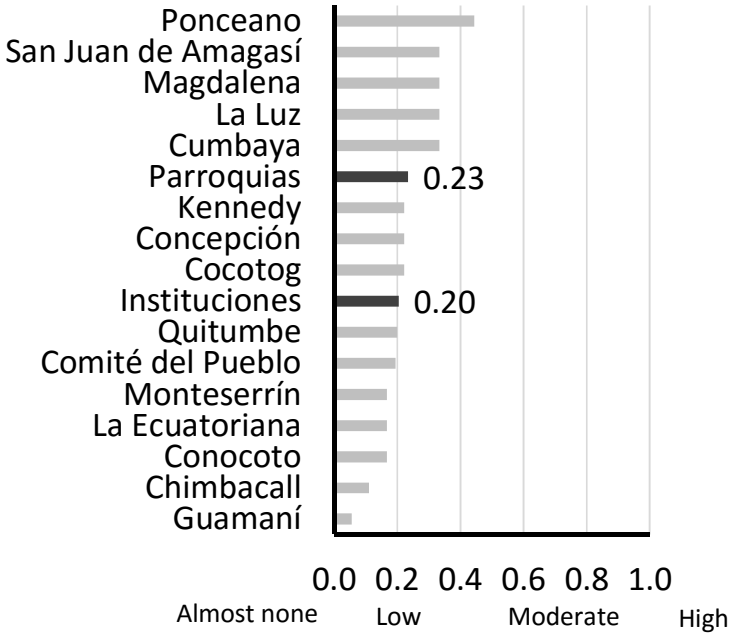


Figure 62 Critical services and public infrastructure resilience: summary by Parishes

4 Performance by resilience dimensions

In order to create benchmarks for monitoring and evaluating resilience and earthquake risk reduction, this section provides indicators obtained for each dimension and component. Table 12 and Figure 63 presents a summary of the results. In general, the scores of the participants reflect a low level of perceived resilience within the city based on the identified gaps in the section beforehand. The lowest indicator scores were obtained for activities related with planning regulation and mainstreaming risk reduction and emergency preparedness, response and recovery.

Table 12 Resilience dimensions indices

Resilience dimension	Community	Public institutions
Awareness and advocacy	0.29	0.42
Social capacity	0.47	0.49
Legal and institutional arrangements	0.32	0.39
Planning regulation and mainstreaming risk reduction	0.21	0.31
Emergency preparedness, response and recovery	0.21	0.31
Critical services and public infrastructure resilience	0.23	0.2

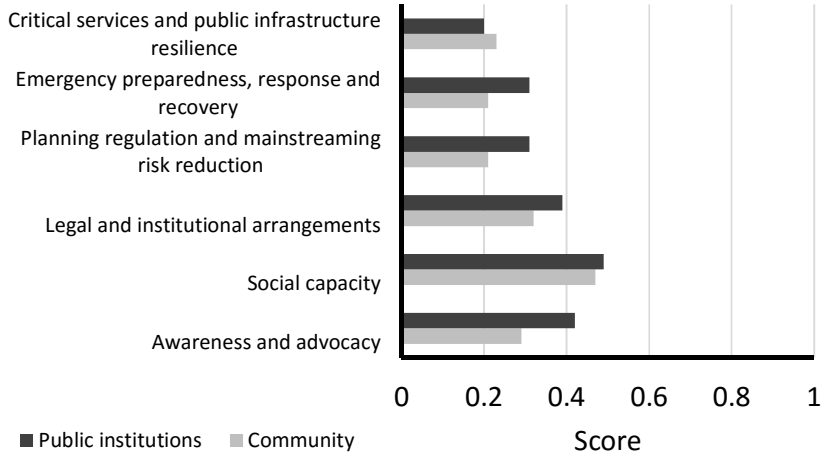


Figure 63 Resilience dimensions indices

4.1 Scores by resilience dimensions

Maximum, average and minimum values of the scores obtained for each component are presented in the following sections. This analysis is useful in order to identify components requiring more efforts in order to improve resilience in Quito, as well as the differences in the scores obtained from community leaders and public institutions.

Awareness and advocacy: Figure 64 presents the scores obtained for each one of the components of awareness and advocacy. Given the results, trainings and capacity building could be promoted considering results from city scenarios and risk estimations of the city.

Lowest score	Trainings and capacity building
Highest score	Participation in public outreach activities
Differences between participants	In general, scores from public institutions are slightly higher; nevertheless, average values are similar. Greater differences are observed for the participation in public outreach activities.

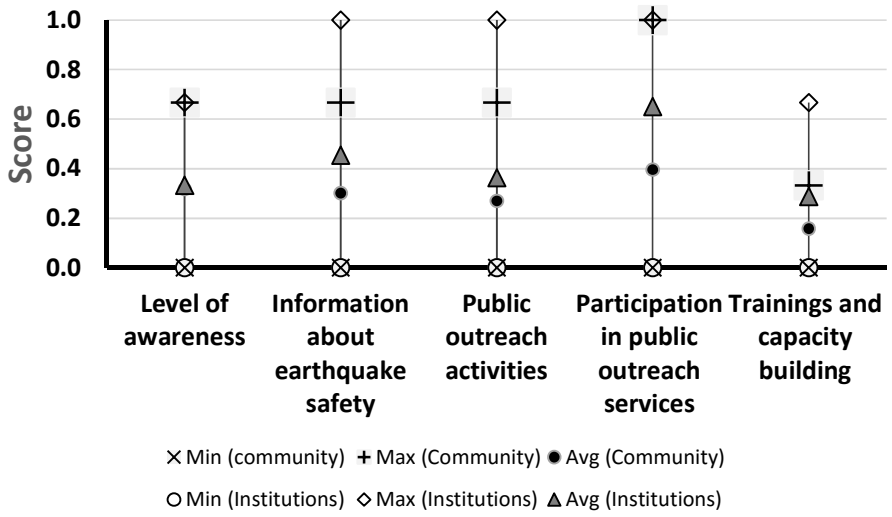


Figure 64 Awareness and advocacy

Social capacity: Figure 65 presents the scores obtained for each one of the components of social capacity. Based on these results, simulation and drills, as well as programs of social inclusion could be promoted in order to improve the ties and connections. Also, mechanisms of participation in decision making could be promoted in order to understand and find solutions to community needs.

Lowest score	Ties and connections, participation in decision making
Highest score	Access to services, primary education
Score differences between participants	In general, average values are similar. Greater differences are observed regarding the interaction between formal (governmental) and informal institutions

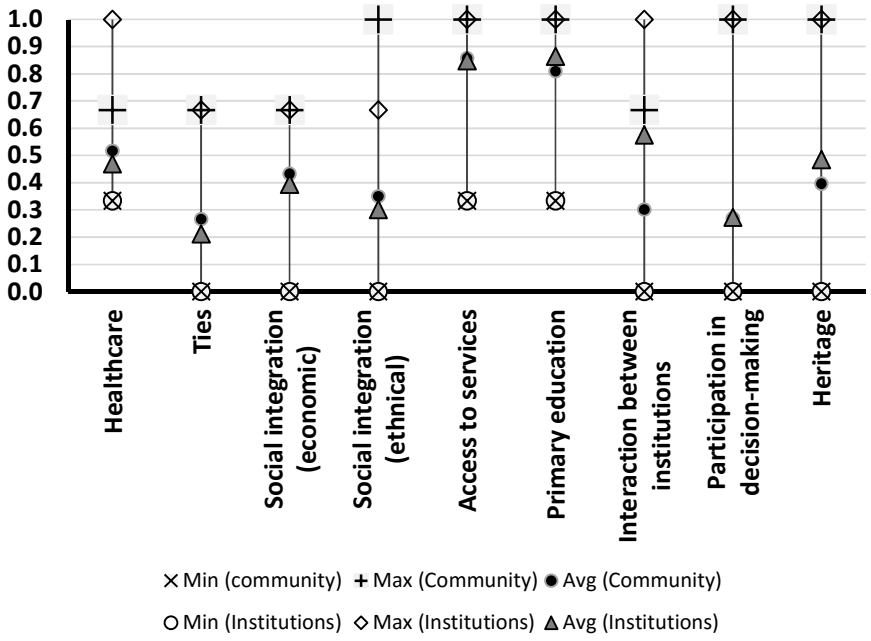


Figure 65 Social capacity

Legal and institutional arrangements: Figure 66 presents the scores obtained for each one of the components of legal and institutional arrangements. Based on these results, mechanisms of participation of community leaders in risk management activities could be promoted. On the other hand, given the confidence in NGOs, programs for community training, risk mitigation and emergency preparedness could be developed through their assistance.

Lowest score	Roles of community leaders, coordination between parishes and parishes with private institutions
Highest score	Coordination Parish-Municipality, confidence on NGO's
Score differences between participants	In general, there are slight differences on the scores. In particular, public institutions consider a lower confidence on the local government than community leaders

Planning regulation and mainstreaming risk reduction: Figure 67 presents the scores obtained for each one of the components of planning, regulation and mainstreaming risk reduction. Based on these results, it is necessary to evaluate and prioritize funds for risk mitigation programs. Also, incentives for risk mitigation of private infrastructure could be considered. A review of insurance mechanisms of public and residential buildings could be of interest.

Lowest score	Insurance; reinforcement of private infrastructure, disaster risk reduction funds
Highest score	Building codes
Score differences between participants	Community leaders consider a lower availability and use of insurance than participants from public institutions

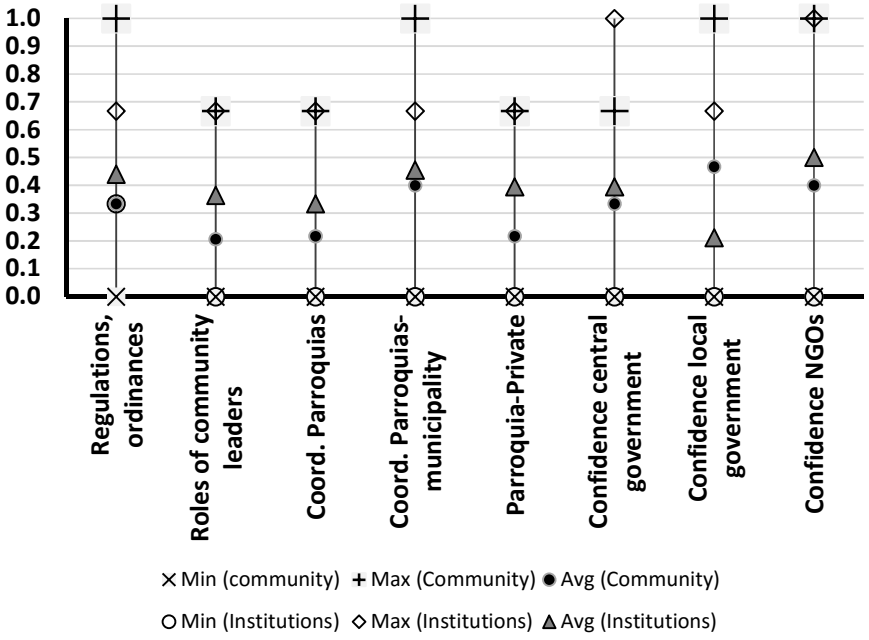


Figure 66 Legal and institutional arrangements

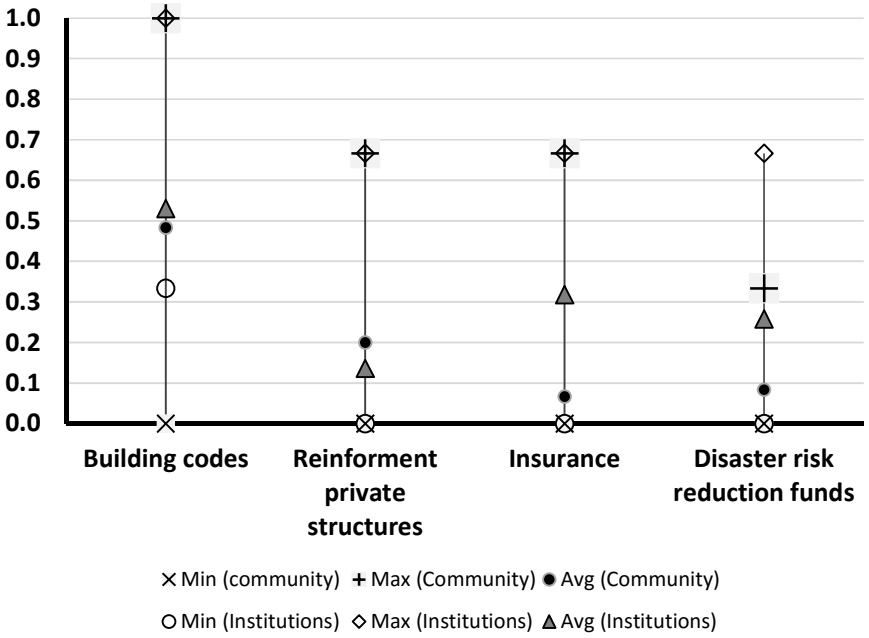


Figure 67 Planning, regulation and mainstreaming risk mitigation

Emergency preparedness, response and recovery: Figure 68 presents the scores obtained for each one of the components of emergency preparedness, response and recovery. Based on these results, it could be considered relevant and timely to implement contingency plans, especially for productivity, livelihoods and strategic infrastructure. Also, the operational procedures for emergency response, as well as the characteristics of centers for emergency response could be better articulated to the public.

Lowest score	Post-earthquake plans for productivity and livelihoods and strategic infrastructure. Standard procedures for emergency response.
Highest score	Human resources and equipment for emergency response
Score differences between participants	There are large differences on the availability of centers for the coordination of emergencies and procedures for emergency response

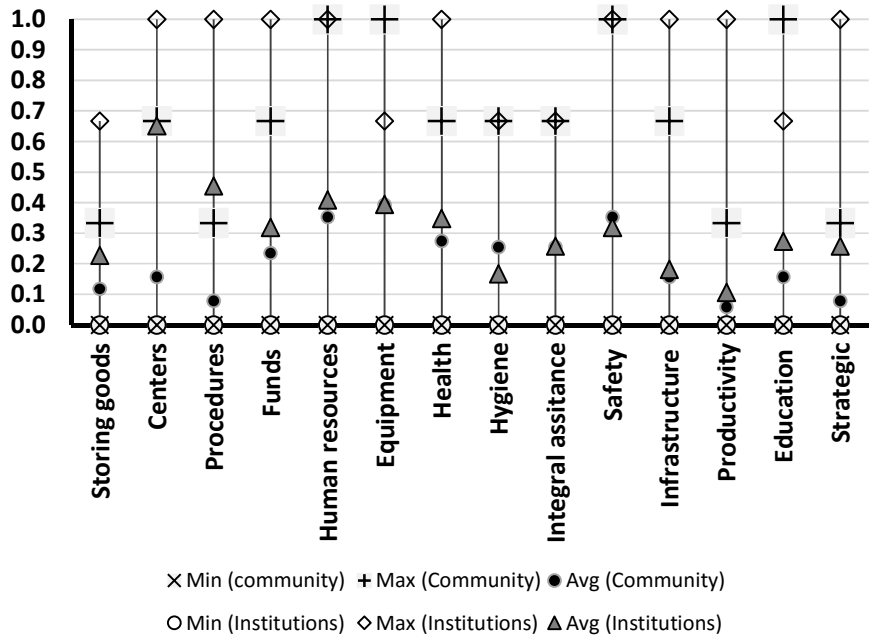


Figure 68 Emergency preparedness, response and recovery

Critical services and public infrastructure resilience: Figure 69 presents the scores obtained for each one of the components of critical services and public infrastructure resilience. Based on these results, it is possible to suggest the implementation of business continuity and recovery plans for critical infrastructure. Also, the reduction of structural and non-structural vulnerabilities of schools and hospitals could be encouraged.

Lowest score	Business continuity and recovery plans.
Highest score	Non structural mitigation in hospitals
Score differences between participants	In general, average values are similar.

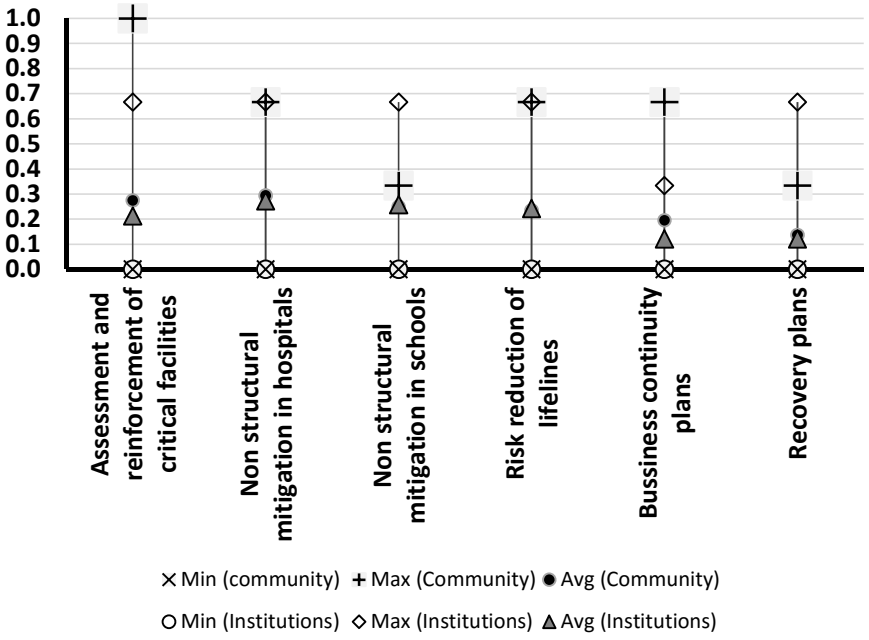


Figure 69 Critical services and public infrastructure resilience

4.2 Scorecard summary

As mentioned before, the scores from community leaders and participants from public institutions reflect a low level of resilience of the City (see Table 13); most of the indices vary between low (73%) and almost none (13%). In this context, it is relevant for the MSIRM of Quito prioritize topics and parishes in order to improve the resilience of the city.

Table 13 Percentage of resilience components by ranges of index

Range of indices		Percentage of components
Almost none	0.0 - 0.1	0%
	0.1- 0.2	13%
Low	0.2- 0.3	28%
	0.3-0.4	28%
	0.4-0.5	17%
Moderate	0.6-0.7	4%
	0.7-0.8	4%
	0.8-0.9	0%
High	0.9-1.0	4%
	1	0%

Table 14 and Figure 70 presents the results of the resilience scorecard of Quito. These results may be useful for the MSIRM of the city in order to identify the type of projects required to improve the capacities of the communities and the public institutions.

Table 14 Resilience scorecard of Quito

Theme	Name	Community	Public institutions
T1. Awareness and advocacy	T1-Level of awareness	0.32	0.33
	T1-Information about earthquake safety	0.30	0.45
	T1-Public outreach activities	0.27	0.36
	T1-Participation in public outreach services	0.40	0.65
	T1-Trainings and capacity building	0.16	0.29
T2. Social capacity	T2-Healthcare	0.52	0.47
	T2-Ties	0.27	0.21
	T2-Social integration (economic)	0.43	0.39
	T2-Social integration (ethnical)	0.35	0.30
	T2-Access to services	0.86	0.85
	T2-Primary education	0.81	0.86
	T2-Interaction between institutions	0.30	0.58
	T2-Participation in decision-making	0.27	0.27
	T2-Heritage	0.40	0.48
T3. Legal and Institutional Arrangements	T3-Regulations, ordinances	0.33	0.44
	T3-Roles of community leaders	0.21	0.36
	T3-Coord. Parishes	0.22	0.33
	T3-Coord. Parishes-municipality	0.40	0.45
	T3-Parishes-Private	0.22	0.39
	T3-Confidence central government	0.33	0.39
	T3-Confidence local government	0.47	0.21
	T3-Confidence NGOs	0.40	0.50
T4. Planning, Regulation and Mainstreaming	T4-Building codes	0.48	0.53
	T4-Reinforment private structures	0.20	0.14
	T4-Insurance	0.07	0.32
	T4-Disaster risk reduction funds	0.08	0.26
T5. Emergency preparedness, response and recovery	T5-Storing goods	0.12	0.23
	T5-Centers	0.16	0.65
	T5-Procedures	0.08	0.45
	T5-Funds	0.24	0.32
	T5-Human resources	0.35	0.41
	T5-Equipment	0.39	0.39
	T5-Health	0.27	0.35
	T5-Hygiene	0.25	0.17
	T5-Integral assistance	0.25	0.26
	T5-Safety	0.35	0.32
	T5-Infrastructure	0.16	0.18
	T5-Productivity	0.06	0.11
	T5-Education	0.16	0.27
	T5-Strategic	0.08	0.26
T6. Critical services and public infrastructure resilience	T6-Assessment and reinforcement of critical facilities	0.27	0.21
	T6-Non structural mitigation in hospitals	0.29	0.27
	T6-Non structural mitigation in schools	0.25	0.26
	T6-Risk reduction of lifelines	0.24	0.24
	T6-Bussiness continuity plans	0.20	0.12
	T6-Recovery plans	0.14	0.12

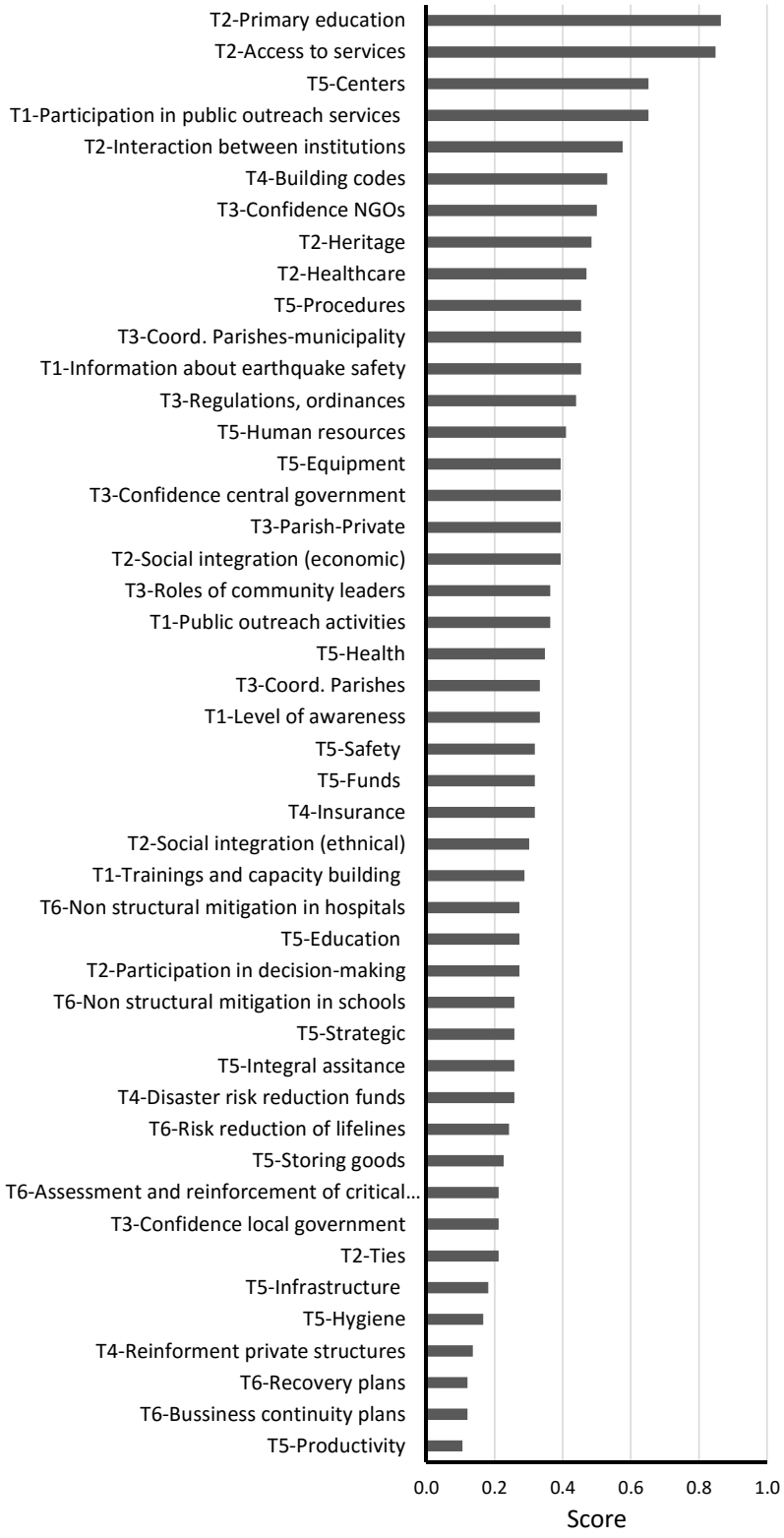


Figure 70 Resilience scorecard of Quito

Finally, Figure 71 presents the results of the resilience scorecard by dimensions and Parishes. Such results may be useful in order to identify sectors within the city requiring higher efforts and investments for enhancing resilience.

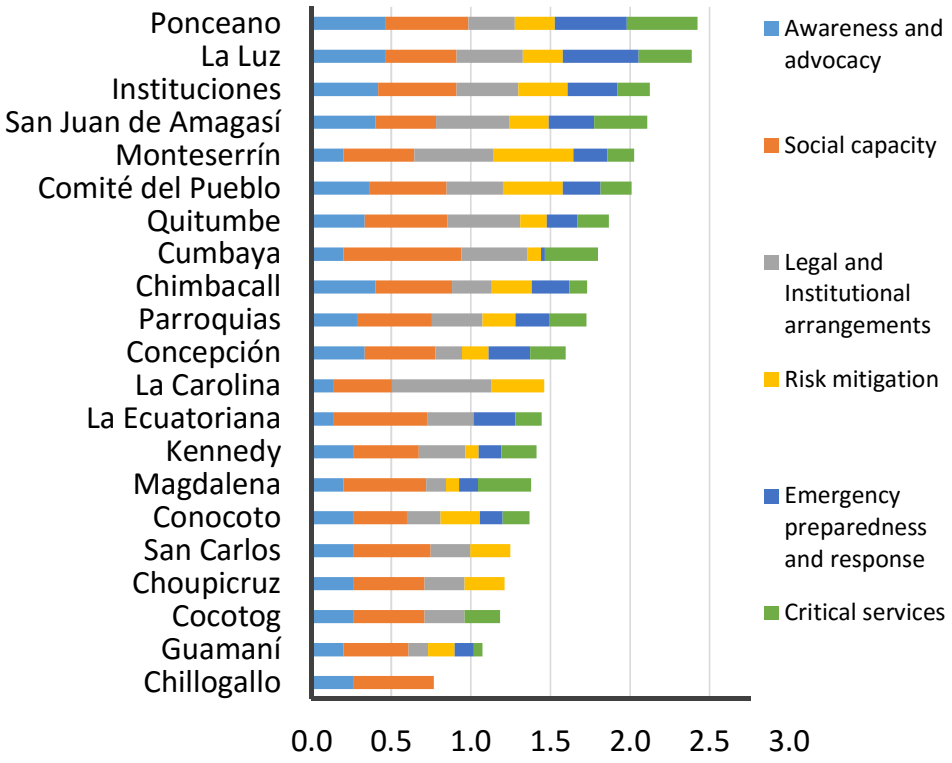


Figure 71 Total score by dimensions and Parishes

5 POTENTIAL ACTIVITIES FOR INCREASING RESILIENCE IN THE CITY

Several projects and activities have been developed in Quito for the purpose of contributing to the enhancement of the capacity of the city to respond to earthquake events. Some of the relevant achievements are:

- Earthquake risk assessment projects.
- The creation of the Metropolitan System of Risk Management of the Metropolitan District of Quito.
- The Program Urban Risk Reduction of Quito. Achievements: (i) a seismic microzonation of the city; (ii) community trainings, (iii) Improvements in local centers for emergency response, a set of safe sites distributed across the city and emergency plans.
- Vulnerability assessment and earthquake risk reduction in schools through the project: "Assessment of vulnerabilities and disaster risk reduction at the municipal scale in Ecuador".
- A recent review of the national building code, as well as a set of Architecture and Urbanism Standards have been approved, containing seismic provisions and earthquake resistant requirements for buildings.

Taking into account the achievements of the city in risk management as well as the results of the resilience scorecard, this section presents, for each dimension and component, relevant topics to include in future agendas and programs of the Metropolitan System of Risk Management of Quito.

Awareness and advocacy: In order to make informed decisions, earthquake risk scenarios and loss estimates, considering residential, critical facilities and relevant economic sectors of the city could be promoted. Such results could be communicated in appropriate language to the public and could be available in a system of information for disaster risk management. A preliminary effort has been achieved through the website of cartography and data regarding risks of the Metropolitan District of Quito [9] Table 15 presents suggested topics to improve awareness and advocacy.

Table 15 Suggested topics to improve awareness and advocacy

Name	Suggested topics
Level of awareness	Promotion of risk identification projects. Implementation of a system of information for disaster risk of Quito.
Information about earthquake safety	The correspondent dissemination of the results, looking for a better understanding of risk within the communities.
Public outreach activities and Trainings and capacity building	To inform a wider audience in campaigns such as those promoted in the Urban Risk Reduction Program.

Social capacity: Use of results of social capacity with both indicators of social vulnerability and estimates of direct losses (physical risk) in order to plan and manage earthquake risk from an integrated perspective. Table 16 presents suggested topics to improve social capacity.

[9] See http://sthv.quito.gob.ec/spirales/index.html#1

Table 16 Suggested topics to improve social capacity

Name	Suggested topics
Ties and connections and integration between parishes	Promotion of drills and emergency plans at the community level (neighborhoods).
Access to public services	To review the coverage and access to public services and consider existing limitations for the design of emergency and contingency plans in order to supply the needs of vulnerable and affected populations after an earthquake.
Access to education	To review the coverage and access to public education and consider such limitations in the design of post-earthquake emergency operations for productivity and livelihoods, as well for education, culture and environment.
Participation in decision making	Promote mechanisms of participation of community leaders in earthquake risk management projects.
Heritage	Given that the city has a huge historical value and has been declared human heritage, efforts could be promoted for retrofitting of public and private buildings.

Legal and institutional arrangement: Considering the organization and functions of the Metropolitan System of Risk Management of the Metropolitan District of Quito, roles and activities could be established in earthquake risk management plans for the city. Table 17 presents suggested topics to improve legal and institutional arrangements.

Table 17 Suggested topics to improve legal and institutional arrangements

Name	Suggested topics
Regulation, ordinance or incentives for earthquake safety	Communication and explanation to the public of national and local regulations and ordinances for disaster risk reduction. Development of a long-term earthquake risk reduction program for the city.
Roles of community leaders in disaster risk management and cooperation between parishes, municipality and NGOs	Promote mechanisms of participation of community leaders and common agendas for disaster risk reduction between Parishes and the Municipality with the collaboration of NGOs. To evaluate the need of new personal and trainings in order to improve the capacity of the staff of the Metropolitan System of Risk Reduction.

Planning, Regulation and mainstreaming risk reduction: Table 18 presents suggested topics to improve aspects related with planning, regulation and risk reduction.

Table 18 Suggested topics to improve planning, regulation and mainstreaming risk reduction

Name	Suggested topics
Earthquake resistant building codes	Strengthening of control mechanisms for the implementation of seismic requirements for the construction of public infrastructure. Analysis of incentives for the mitigation of private infrastructure.
Budget for disaster risk reduction	Review of budget limitations and needs for promoting risk reduction projects. Design projects and proposals to be funded by for international donors and organizations. Communicate clearly to the population the budget limitations as well as the criteria and procedures used for prioritizing interventions
Availability and use of insurance	Review and analysis of insurance regulations, household capacities and mechanisms of insurance o public infrastructure and residential buildings.

Emergency preparedness, response and recovery: Table 19 presents suggested topics to improve aspects related with planning, regulation and risk reduction.

Table 19 Suggested topics to improve emergency preparedness, response and recovery

Name	Suggested topics
Standard operational procedures for coordinating emergency rescue and response activities	Dissemination and communication of existing operational procedures. Promotion of community simulations and drills.
Local centers for implementing and coordinating emergencies	Promote public outreach activities in order to inform characteristics of local centers for emergency coordination.
Funds for emergency response and recovery	Evaluate potential costs and financial needs for post-earthquake operations and identify potential financial sources. Evaluate the capacity of the Fund for Risk Management and Emergency attention of Quito.
Resources for emergency response and recovery	Create a system of information of resources for emergency attention. Evaluate the response capacity of the city by comparing current inventories with estimates of potential damages.
Contingency plans	Implement contingency plans regarding earthquake events. Promote public outreach activities in order to inform the progress of the implementation of contingency plans. Promote simulation and drills with communities in order to test available contingency plans.

Critical services and public infrastructure resilience: Table 20 presents suggested topics to improve critical services and public infrastructure resilience.

Table 20 Suggested topics to improve emergency preparedness, response and recovery

Name	Suggested topics
Assessment and retrofitting of critical facilities and reduction of non structural vulnerabilities	Continue the implementation of the campaign of hospitals safe from disasters. Promote the assessment of vulnerabilities of educational facilities and promote non structural interventions within national and local programs. Promote the vulnerability and risk assessment of lifelines and support risk mitigation works.
Business continuity and post-earthquake recovery plans for lifelines	Promote the definition and implementation of post-earthquake recovery plans for lifelines. Identify financial sources for recovery works. Promote the implementation of business continuity plans for public services, as well as simulation and drills in order to review and adjust them.

5.1 Final comments

This report presents the methodology and application of the Resilience Performance Scorecard (RPS) for the Metropolitan District of Quito. This effort was useful in order to evaluate the status, gaps and current achievements of key resilience dimensions in the city. Based on this analysis, a set of potential activities for increasing the capacity of population and public institutions was suggested in order to contribute to the development of a long-term earthquake management plan in Quito. In this regard, the scorecard provides a useful diagnosis of the resilience of the city and facilitates the construction, update and prioritization of strategies with the participation of public institutions and community leaders.

As a complement to the analysis of the resilience of the city, the SARA project has also facilitated the development of earthquake risk scenarios and indicators of social vulnerability to earthquakes for the city. The seismic scenarios will be based on detailed data of residential buildings, recent and publicly available models of seismic hazard and physical vulnerability, contributing to a reliable estimation of earthquake losses. On the other hand, the analysis of indicators of social vulnerability will be useful to identify communities with lower capacities to mitigate and to absorb potential adverse effects if a damaging earthquake were to occur.

Such efforts have been developed in collaboration with researchers from the Polytechical School of Ecuador (EPN) and will be useful for a better understanding of losses and to establish a comprehensive and public risk management agenda.

AKNWOLEDGEMENTS

This report was produced as part of the South America Risk Assessment project (SARA) with financial support provided by the Swiss Re Foundation. The authors would like to express sincere gratitude to the staff of the Metropolitan System of Risk Management of Quito for their collaboration and participation in the workshop. In particular to Alejandro Terán, head of the Metropolitan Directorate of Risk Management, for his support and profound interest in the analysis of earthquake resilience of the city.

REFERENCES

ALNAP (2005) "Quito, Ecuador, Disaster Risk Management Profile. 3CD City Profiles Series – Current Working Document. [On line]. Available at: http://www.alnap.org/resource/7273 [Last checked 29/09/2015].

Applied Technology Council (1988) Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook (Report ATC-21). Applied Technology Council (ATC), Redwood City, California.

Beauval, C., Yepes, H., Audin, L., Alvarado, A., Nocquet, J.M., Monelli, D., Danciu, L. (2014) "Probabilistic Seismic-Hazard Assessment in Quito, Estimates and Uncertainties" Seismological Research Letters; 85 (6)

Carrion, D., Vasconez, J., Bermudez, N. (2003) "Urban Slums Reports: The case of Quito, Ecuador". Understanding slums: Case Studies for the Global Report 2003. UN-Habitat. [On line]. Available at: http://www.ucl.ac.uk/dpu-projects/Global_Report/pdfs/Quito.pdf. [Last checked 02/10/2015].

Cimellaro, G.P., Reinhorn, A., Bruneau, M. (2006) "Quantification of Seismic Resilience". 8th National Seismic Conference, San Francisco, April 2006.

Consejo Metropolitano de Quito (2008). "Ordenanza Metropolitna 0265 de 2008". Ordenanza Metropolitna para la creación del Sistema Metropolitano de Gestión Integral de Riesgos del Distrito Metropolitano de Quito y sus componentes.

Cornejo, M (2015) "Ecuador. Informe Nacional del Progreso en la Implementación del Marco de Acción de Hyogo (2013-2015)". A National HFA Monitor update published by PreventionWeb. [On line]. Available at: http://www.preventionweb.net/files/40145_ECU_NationalHFAprogress_2013-15.pdf [Last checked [30/09/2015].

Cutter, S.L., B.J. Boruff and W.L. Shirley (2003) ''Social Vulnerability to Environmental Hazards'', Social Sciences Quarterly 84(2): 242–261

D´Ercole, R., Metzger, P. (2002) "Los lugares esenciales del Distrito Metropolitano de Quito". Institut de Research for Development (IRD). Metropolitan District of Quito. [On line]. Available at: http://sthv.quito.gob.ec/spirales/3_publicaciones/libros/Los_lugares_esenciales_del_dmq.pdf [Last checked 08/10/2015].

D´Ercole, R., Metzger, P. (2004) “La vulnerabilidad del Distrito Metropolitano de Quito”. ”. Institute of Research for Development (IRD). Metropolitan District of Quito. [On line]. Available at: http://sthv.quito.gob.ec/spirales/3_publicaciones/libros/La_vulnerabilidad_del_dmq.pdf [Last checked 08/10/2014]

DEMORAES, F. (2005) “Movilidad, elementos esenciales y riesgos en el Distrito Metropolitano de Quito”. ”. Institute of Research for Development (IRD). Metropolitan District of Quito. [On line]. Available at: http://sthv.quito.gob.ec/spirales/3_publicaciones/libros/Movilidad_elementos_esenciales_y_riesgos_en_el_dmq.pdf [Last checked 08/10/2014]

El Ciudadano (2014) “Estado atiende a afectados por sismo en Quito (VIDEO)”. [On line]. Disponible en: http://www.elciudadano.gob.ec/estado-atiende-a-afectados-por-sismo-en-quito-video/ [Last checked 05/10/2015]

FERNANDO ROMO CONSULTORES CIA LTDA (1989) “Estudio para la reconstrucción y restauración estructural de varias iglesias del Centro Histórico de Quito”.

El Comercio (2014 a) “El seguro para cubrir desastres cayó un 7%”. [On line]. Available at: http://www.elcomercio.com/actualidad/seguro-cubrir-desastres-casas-cayo.html [Last checked 06/10/2015].

El Comercio (2014 b) “Reforzamiento de colegios municipales”. [On line]. Available at: http://www.elcomercio.com/cartas/roberto-aguiar-falconi-opinion-reforzamiento.html [Last checked 12/10/2015]

El Comercio (2014 c) “Sismo en Quito afectó temporalmente la fibra óptica de Movistar”. [On Line]. Disponible en: http://www.elcomercio.com/actualidad/sismo-quito-afecto-fibra-optica.html [Last checked 16/10/2015].

El Telégrafo (2015) “Más de $ 3,5 millones se invirtieron para remodelar infraestructura del colegio Mejía”. [On line]. Available at: http://www.telegrafo.com.ec/sociedad/item/mas-de-35-millones-se-invirtieron-para-remodelar-infraestructura-del-colegio-mejia.html [Last checked 12/10/2015]

EPMAPS (2013) “Memoria de sostenibilidad 2013”. Empresa Pública Metropolitana de Agua Potable y Saneamiento. [On line]. Available at: http://www.aguaquito.gob.ec/sites/default/files/documentos/mds_epmaps_2013.pdf [Last checked 15/10/2015].

EPN-IMQ-OYO CORPORATION-GEO-HAZARDS INTERNATIONAL-ORSTOM (1995) "Proyecto para el Manejo del Riesgo Sísmico de Quito. [On Line].Escuela Politécnica Nacional, GeoHazards International. Available at: http://www.geohaz.org/contents/projects/quito1.htm

Fernández, J., Hoefer, G., Tucker, B. (1996). “Identifing and retrofitting high-risk schools in Quito, Ecuador”. Proceedings of the Eleventh World Conference on Earthquake Engineering. Paper No. 999. Acapulco. Mexico.

FONSAL (2004) “Memorias del Seminario Taller: Reforzamiento Estructural en las Edificaciones Patrimoniales “ Quito, 15- 19 de Septiembre de 2003. Municipio del Distrito Metropolitano de Quito. Fondo de Salvamento del Patrimonio Cultural. ISBN 9978-92-349-7

GeoHazards International (1995) “Invirtiendo en el futuro de Quito. Proyecto de Seguridad Sísmica de las edificaciones escolares de Quito, Ecuador”. Escuela Politécnica Nacional [On line] Available at: http://www.geohaz.org/news/images/publications/QuitoSchoolProjectSpanish.pdf [Last checked 03/09/2013]

Jalil, Y. (2013) “Evaluación del Resultado 306: Fortalecimiento del Sistema Nacional Descentralizado de Gestión de Riesgos (SNDGR) en Ecuador” Informe Final.

Khazai, B., Bendimeard, F., Cardona, O.D., Carreño, M.L., Barbat, A.H., Burton, C.B (2015) “A Guide to measuring urban resilience. Principles, tools and practice of urban indicators” Earthquake Megacities Initiative (EMI).

Mena, A., Serrano, T. (2002) “Salud y Riesgos en el Distrito Metropolitano de Quito”.Análisis espacial y vulnerabilidad de los establecimiento de salud” Cooperación Científica y Técnica entre el Municipio del Distrito Metropolitano de Quito (MDMQ) y el Institut de Recherche pour le Développement (IRD) Programa de investigación “Sistema de Información y Riesgos”. [On line]. Available at: http://sthv.quito.gob.ec/spirales/3_publicaciones/libros/Salud_y_riesgos_en_el_DMQ.pdf [Last checked 13/10/2015].

Manitio-Cahuatijo, G.J., Vasconez-Villa, S.B., Placencia, P. (2013) “Estudio de Vulnerabilidad y Reforzamiento Estructural de un Inmueble Patrimonial del Distrito Metropolitano de Quito” pp 184.

Martinellia, D., Cimellaro, G.P., Terzic, V., Mahin, S. (2014) “Analysis of Economic Resiliency of Communities Affected By Natural Disasters: The Bay Area Case Study”. 4th International Conference on Building Resilience, Building Resilience 2014, 8-10 September 2014, Salford Quays, United kingdom. *Procedia Economics and Finance* 18, 959 – 968

Official Register of Ecuador (2015) “Actualízace y oficialícese la Norma Ecuatoriana de la Construcción. Año II No 413 “. [On Line]. Available at: http://www.normaconstruccion.ec/capitulos_nec_2015/nec_registro_oficial_0047.pdf [Last checked 16/10/2015].

Proaño-Castro, D. (2012) Plan de Emergencias para el DMQ. Bases Fundamentales, Roles y Responsabilidades. Plan de Emergencias para el MDMQ, en base a guías y formatos internacionales. Sistematización de la información disponible. Primera propuesta para discusión

Qachet-Giacometti, P. Fernández, J. (1996) “Proyecto de vulnerabilidad sismica de edificaciones hospitalarias de la ciudad de Quito”. Organizacion Panamericana de la Salud. Escuela Politecnica Nacional. Facultad de Ingeniería Civil. Departamento de Estructuras.

Secretaria Metropolitana de Salud (2015) “Plan Estratégico 2015-2025” Municipio del Distrito Metropolitano de Quito. [En Línea]. Disponible en: http://www.quito.gob.ec/documents/Plan_Estrategico_SMS_marzo2015.pdf [Last checked 02/072015].

[1] UNISDR 2009, UNISDR Terminology on Disaster Risk Reduction, United Nations International Strategy for Disaster Risk Reduction, Geneva, Switzerland.

Yépez-Moya, F. (2001) "Últimos avances en la evaluación del riesgo sísmico de Quito y futuros proyectos de mitigación"Memorias del Seminario Gestión de riesgos y prevención de desastres Quito, 24-25 de enero de 2001. Cooperazione Internazionale (COOPI). Facultad Latinoamericana de Ciencias Sociales (FLACSO).

Serrano, T. (2004) "Análisis de la reducción de la vulnerabilidad en el Distrito Metropolitano de Quito- Los aspectos más desarrollados, las mayores dificultades y las perspectivas a futuro. Cooperación Científica y Técnica entre el Municipio del Distrito Metropolitano de Quito (MDMQ) y el Institut de Recherche pour le Développement (IRD) Programa de investigación "Sistema de Información y Riesgos". [On line]. Available at:
http://sthv.quito.gob.ec/spirales/3_publicaciones/libros/Analisis_de_la_reduccion_de_la_vulnerabilidad_en_el_dmq.pdf
[Last checked 13/10/2015]

Web sites

Geophysical Institute of Ecuador. What to do in case of earthquake?
http://www.igepn.edu.ec/que-hacer-ante/un-sismo
[Last checked 07/10/2015]

Statistics of the Metropolitan District of Quito- Public services
http://sthv.quito.gob.ec/index.php?option=com_content&view=article&id=28&Itemid=90
[Last checked 02/10/2015]

Statistics of the Metropolitan District of Quito – Poverty indicators
http://sthv.quito.gob.ec/images/indicadores/pobreza.htm
[Last checked 02/10/2015]

Metropolitan Institut of Heritage of Quito
http://www.patrimonio.quito.gob.ec/index.php/servicios-ciudadanos/recupera-tu-casa
[Last checked 02/10/2015]

Ministery of Education of Ecuador. Master archive of Educational Facilities–AMEI
http://reportes.educacion.gob.ec:8085/index.aspx
[Last checked 02/10/2015]

National Institut of Statistics and Census - Poverty
http://www.ecuadorencifras.gob.ec/pobreza/
[Last checked 05/10/2015]

Secretariat of Land, Habitat and Housing. Cartography and Data of the Metropolitan District of Quito.
http://sthv.quito.gob.ec/spirales/index.html
[Last checked 08/10/2015]

ANNEX I: AGENDA

Agenda

Jueves 23 de Julio de 2015

8:30	9:00	Registro
9:00	9:30	Bienvenida e introducción
9:00	9:15	Visión general del riesgo de desastre comunitario y resiliencia
9:15	9:30	Introducción al propósito de la tabla de puntuación
9:30	11:00	Sesión participativa I: Evaluación de la tabla de puntación con representantes de la comunidad
11:00	11:15	Descanso
11:15	13:00	Continuación de la sesión participativa: evaluación de la tabla de puntuación con representantes comunitarios
13:00	14:00	Almuerzo
14:00	15:30	Sesión participativa II: Presentación y discusión de resultados
15:30	15:45	Descanso
15:45	16:30	Sesión de cierre: Resumen de necesidades y vacíos

Viernes 24 de Julio de 2015

8:30	9:00	Registro
9:00	9:30	Bienvenida e introducciones
9:00	9:15	Visión general del riesgo de desastre comunitario y resiliencia
9:15	9:30	Introducción al propósito de la tabla de puntuación
9:30	11:00	Sesión participativa I: Evaluación de la tabla de puntación con representantes del municipio
11:00	11:15	Descanso
11:15	13:00	Continuación de la sesión participativa: evaluación de la tabla de puntuación y discusión con representantes del municipio
13:00	14:00	Almuerzo. Participantes de la comunidad y del municipio están invitados a almorzar
14:00	15:30	Sesión participativa II: Discusión de resultados con los representantes de la comunidad y del municipio
15:30	15:45	Descanso
15:45	16:30	Sesión de cierre: resumen de necesidades y vacíos con representantes de la comunidad y del municipio