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Land policies for landslide risk reduction in Andean cities

Highlights

- The landslide susceptibility of the Andes demands more risk reduction research to be conducted.
- Landslide risk reduction practices have been proven successful by articulating bottom-up approaches.
- Risk reduction networks across formal structures are more effective than cliché policies and grouped actors.
- Understanding Andean informality may lead to strategic landslide risk reduction and climatic adaptation.

Abstract

Andean cities are increasingly subjected to landslide susceptibility and events, accompanied by population and urban growth and uncertain extreme climate events. In light of this, academic and professional communities have begun to pay close attention and now face the challenge of producing more detailed knowledge and converting it into effective action.

This article is based on a literature review supporting a multidimensional conceptual framework to address landslide risk reduction for the urban Andes context. It aims to complement the environmental dimension, which often shows the resulting physical condition of risk, with landslide risk root-causes by exploring socio-economic and socio-cultural dimensions and the policy and institutional apparatuses that accompany the former dimensions. We aim to identify and understand the inextricable links between the four dimensions and determine how subdimensions can operatively describe and help to understand this complexity. An example from a landslide risk-prone site in Quito illustrates the application of the framework and delivers lessons from a specific context and time. Parts of these lessons may be common for other contexts, but their understanding is critical for landslide risk reduction.

Keywords: Latin America, risk-sensitive, land-use, informality, vulnerability, social construction

Table of Contents

1. INTRODUCTION.....	3
2. DEFINITIONS OF KEY CONCEPTS.....	4
3. A CONCEPTUAL FRAMEWORK LINKING LP AND LRR	5
3.1. BUILT AND NATURAL ENVIRONMENT.....	6
3.1.1. Landslide Susceptibility (LS) and environment	6
3.1.2. Climate Change Adaptation (CCA)	7
3.1.3. Physical Vulnerability of Buildings	8
3.2. SOCIO-ECONOMIC CONDITIONS.....	8
3.2.1. Land Value and Spatial Equity.....	8
3.2.2. Captivity to Risk.....	9
3.2.3. Community willingness to invest in LRR.....	9
3.3. SOCIO-CULTURAL FACTORS	10
3.3.1. Root Causes and Social Construction of Risk.....	10
3.3.2. Constructivist Value of Risk.....	11
3.3.3. Informal Urban Settlements.....	12
3.4. POLICY AND INSTITUTIONAL FACTORS.....	13
3.4.1. Risk-Sensitive LUP (RS-LUP).....	13
3.4.2. Land and Urban Management.....	14
3.4.3. Politics and LRR Policies	16
3.5. OPERATIONAL TABLE FOR THE FRAMEWORK	16
4. APPLICATION OF THE FRAMEWORK TO A CASE STUDY SITE	18
4.1. SITE PROFILE	18
4.2. OPERATIONALIZATION INSTRUMENTS AND SOURCES	20
4.3. COLLECTED RESULTS FOR EACH DIMENSION.....	20
4.3.1. <i>Environment: The Colonized Arid Banks</i>	20
Landslide Susceptibility: Witnessed and Expected Events	20
CCA: Two attitudes.....	22
Built Vulnerability: Null Enforcement	22
4.3.2. <i>Socio-Economics: Misleading the Naive Poor</i>	23
Land Value: Market Circumvents Risk	23
Captivity: No Place to Go	23
LRR Willingness: What is Offered?.....	24
4.3.3. <i>Socio-Cultural: Risk Capitalization and Determinism</i>	24
Root-Causes: Producing Risk in the Basin	24
Constructivism: Whatever Happens... ..	26
Informality: Self-Built Risk.....	26
4.3.4. <i>Policy-Institutional: Formal Gaps Fostering the Illegitimate</i>	27
RS-LUP: Piecemeal Planning	27
Risk Management: Piecemeal Actions.....	28
Politics: Overlapping Responsibilities, Clientelism and Disdain	29
4.4. DISCUSSION ABOUT THE INTER-DIMENSIONAL RELATIONS.....	29
5. CONCLUSIONS.....	32

1. Introduction

Evidence shows the need for addressing landslide risk (LR) in Latin America and the Caribbean (LAC) through adequate land policies. The Sendai Framework for Disaster Risk Reduction 2015–2030 (SFDRR), as the global policy for Disaster Risk Reduction (DRR), proposes integrated multidimensional measures to reduce disaster risks (UNISDR, 2015). The 2017 United Nations Office for Disaster Risk Reduction Report (UNISDR, 2018) states that landslides are key hazards for the Americas. In particular, the Andes has been subjected to high susceptibility and fatalities. In this regard, Sepúlveda and Petley (2015) highlighted the deficit of related research on this region and emphasizes the need to better understand the production of landslides in LAC to manage their heterogeneous distribution. Fatal events in South America are noticeably concentrated in the Andes. This is due to uncontrolled urbanization and environmental degradation, densification, a growing -but deaccelerating- 70% urban population, unfavorable geodynamics and climate, while ignoring local vulnerabilities (D’Ercole, Hardy, Metzger, & Robert, 2009; UNISDR, 2018)

Improved urban land-use planning (LUP) and the implementation of landslide disaster risk reduction (LRR) measures are demanded for the exposed families. Limited peer-reviewed research has addressed risk-reductive land policies (LP) in the Andes. Alongside global disaster risk management (DRM) policies, planning systems for this region experience reforms, particularly in the last decade. The Comunidad Andina Organization (2017) has identified DRM challenges in the Andes such as the achievement of adequate settlement processes, social and institutional capacities, responsibility sharing and vulnerability reduction.

This article stresses the need for improved LUP to effectively reduce the LR of existing urbanized areas, considering risk drivers from a multidimensional, integrated perspective and shaping diverse realities. Although global, regional and local land policies greatly promote DRR, implementation remains insufficient in Andean cities and this problem is presented in this article. Section 1 introduces a background, review process, problem statement and objectives. Section 2 defines key concepts regarding disaster risk (DR) and urban planning. Section 3 describes the conceptual framework, designed from a constructivist, heuristic and multidimensional perspective. A synthetic set of 83 references, out from 114 initially analyzed ones, are presented to support the

framework. The databases searched were ScienceDirect (50%), Taylor&Francis (11%), Springer (7%), SAGE (6%), JSTOR (4%), Wiley (4%) and other sources (18%). Subjects covered were DRM (68%), LUP (30%) and social studies (2%). Regarding context, literature included non-Andean LAC pieces (18%) and Andean (48%). Finally, 86% of the reviewed literature was published in the 2010s. Section 4 presents a framework application to a neighborhood case study in Quito, Ecuador, with a contextualized discussion. Lastly, a set of conclusions are presented as a summarized contribution of this work, while guiding further research for the authors and readers.

2. Definitions of Key Concepts

Among a number of disaster risk conceptualizations, Etkin (2016) defines it as equal to hazard multiplied by vulnerability, leaving exposure implicit. In any case, hazard–vulnerability combinations affect risk. Complementing this, UNISDR (2016) define DRM as the application of policies to prevent new, reduce existing and manage residual DR to strengthen resilience and reduce losses. The Andes, as with many developing regions, generally lack preventative actions and DRM in building and urban development point to corrective instead of preventative measures. This is intuitive, considering the relevance of informal settlements in the region. In this context is pertinent to understand the concept of corrective DRM, which promotes risk generation alleviation, differing from prevention, which advocates for no risk generation (Lavell and Maskrey, 2014).

A landslide is defined by Highland and Bobrowsky (2008, p.4) as *“the downslope movement of soil, rock, and organic materials under the effects of gravity”*. Types are diverse and the causes are geological, morphological or anthropic. Noticeably, water, seismic and volcanic activities are triggering factors. Sepúlveda and Petley (2015) suggest that observed landslide distributions in LAC are best explained by topography, annual precipitation and population density. An extensive landslide susceptibility review suggests that the most determining factors are slope, aspect and geology, with variations (Reichenbach, Rossi, Malamud, Mihir, and Guzzetti, 2018).

LR could be determined by the presence of hazardous soil before vulnerable conditions of constructions and by exposing vulnerable construction to risky land. In addition, for this conceptual review, landslides are considered as extensive disasters, defined by UNISDR (2016) as low-severity and high-frequency events associated with the human scale, and are distinct from intensive disasters. Furthermore, landslides,

as extensive disasters, are exacerbated by poverty, urbanization and environmental degradation. Alcántara-Ayala (2019) highlights the significance of extensive disasters, whose accumulated impact is equal to or greater than intensive disasters, weakening societies. Unfortunately, extensive landslides are not treated by the media and politicians as being suitable for learning (Voss and Wagner, 2010).

This work's multidimensional approach points to LRR in the preventive stages of the DRM spiral process. However, LUP instruments importantly support all stages in DRM. Built environment professionals, politicians, community and all related actors must learn from experience to avoid recurrent mistakes in DRM. Paradoxically, regardless the production of new DRM policy knowledge, disasters are increasing (Pigeon and Rebotier, 2016). Hence the need to convert learning into actions for new corrective and preventive LUPM. In this line of thought, the SFDRR have called for LUP to enhance DRR (UNISDR, 2015).

Socio-economically, it is better to reduce LR than to remediate and recover from landslides. Facing accelerated unplanned urbanization in a changing climate, LRR measures can become convenient land management (LM) practices for government and the community. Nonetheless, there is little evidence of action-oriented LP for LRR. In LAC, a good example is the *MoSSaiC program* in Saint Lucía—a proven cost-effective slope stability program—(Holcombe, Anderson, & Holm-Nielsen, 2013). This case highlights active multi-actoral participation with multiple-way knowledge transfer for success.

3. A Conceptual Framework Linking LP and LRR

This study unbundles the LUPM–DRR approach into four dimensions spanning the evolution of LUP in LAC. However, LAC struggle to integrate normative physical planning with implementation management (Gallo, 2012), thus requiring complementary human sciences approaches. This framework aims to assess the conditions and potentials of cities to enable LP for LRR by covering the natural/built environment, socio-economic, socio-cultural and policy-institutional dimensions—and its systemic nature— (see **Figure 1**). For instance, land tenure is often demanded to politicians, who may approve risky settlements due to clientelism. This legalizes unsafe practices by leveraging politicians and community agents, while stimulating a toxic culture. Demands for housing, land and jobs may pressure policymakers to relax regulations, placing the poor in danger as the cost of providing access to cities.

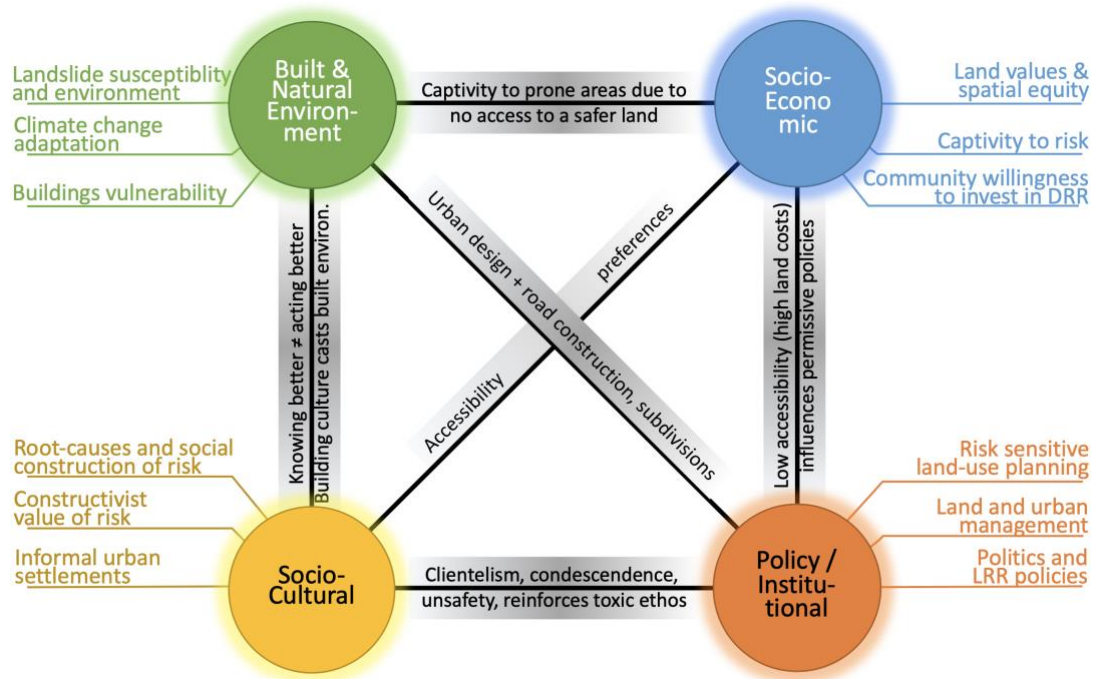


Figure 1. Interrelations between environmental, socio-economic, socio-cultural, and policy dimensions of land-use planning and management (LUPM) for landslide disaster risk reduction (LRR). By J. Teller and F. Puente.

3.1. Built and Natural Environment

3.1.1. Landslide Susceptibility (LS) and environment

Landslide susceptibility approaches are based on traits of urbanization and nature, combined to produce LR. Reichenbach, Rossi, Malamud, Mihir, and Guzzetti (2018) define LS as the likelihood of the occurrence of landslides in terrains depending on certain conditions, including climate. Susceptibility is often a large-scale, aggregate appraisal, different from threat or vulnerability analyses. Susceptibility analyses rely on data quality, methods and interpretation. These authors' vast LS review concluded that slope and lithology are the most significant factors, with variations. LS studies focusing on South America have found precipitation, population density and land use to be significant (Sepúlveda & Petley, 2015).

In the Andes, a few LS works have used diverse modeling approaches, such as in Envigado, Colombia; and in Quito and Loja, Ecuador (Marin and Mattos, 2019; Puente-Sotomayor, Mustafa, and Teller, 2020; Soto et al., 2017). Other approaches such as climate-related or rainfall-induced methods complement a basic LS studies background for the region; however, many works claimed to suffer from a lack of data or its appropriate format for modeling (Bloch et al., 2014; H. Frey et al., 2016; Hoyos, Escobar, Restrepo, Arango, and Ortiz, 2013; Huggel et al., 2015).

3.1.2. Climate Change Adaptation (CCA)

The Andes periodically face three climatic phases: El Niño (warm and rainy), La Niña (cold, dry and with eastwardly wind) and a neutral one. The former often causes landslides; however, climatic variability has been found to be a non-negligible cause, which must be considered for risk-sensitive land policy design (Rodríguez-Morata, Villacorta, Stoffel, and Ballesteros-Cánovas, 2019).

The Andes suffer high variability in precipitations due to their orography, altitude and microclimates. This likely produces shallow landslides, debris flows, rock slope fails and ice avalanches more frequently and greater in magnitude, as in Cordillera Blanca, Peru. Andean temperatures will differ by between 3.5 °C and 1 °C for the 2071–2100 period compared to the 1961–1990 period (Stoffel and Huggel, 2012). These uncertain changes lead to localized multiple threats; unfortunately, the Andean people are not able to adapt to them. Instead, they adapt CC to their lives and their religion is linked inextricably to nature, interpreted with entangled narratives (Rasmussen, 2016; Scoville-Simonds, 2018).

The Northern Andes receive more annual precipitation than other South-American locations, eventually reduced in moisture production due to deforestation in the Amazonia. Annual rainfall erosivity is projected to be highest in the Central and Southern Andes for the 2010–2040 period, leading to sandy soils, scarce vegetation, strong steepness and landslides (Riquetti, Mello, Beskow, and Viola, 2020). Persistent rainfall on eastern-central Andes at lower elevations may be related to advection from the Amazon basin (Barros, 2013; O'Hare & Rivas, 2005). Climatic threats and soil erosion here increase with deforestation producing soil inconsistency, impacting the hydrological balance (Ochoa-Tocachi, 2018). Reductions in water sources, climate change, population densification and melting glaciers increase LR, demanding management and awareness regarding rural–urban migration and land-use changes pressures. Unsuitedly, this has often been investigated in isolated disciplines (Córdoba Vargas, Hortúa Romero, & León-Sicard, 2020; Mulligan et al., 2010; UNEP & GEAS, 2014). Marginality combined with CC-related events reveal indigenous claims for resources threatened by modernity; namely, land in Ecuador, water in Bolivia and biodiversity in Colombia (Spikin and Hernández, 2016).

In the Andes, CCA requires policy prioritization based on bottom-up integration and multi-actor involvement, beyond scientific assessment, from problematization to

implementation (Huggel et al., 2015). A similar call for a socio-scientific approach, followed by keen communication, independency from political clientelism and process disruption, is supported by H. Frey et al. (2016) and Ramírez (2018).

3.1.3. Physical Vulnerability of Buildings

Buildings vulnerability produces LR when standards regarding structures resistance, soil shaping, and layouts are not followed. In Medellín, Colombia, for instance, if buildings would comply with building codes, losses would drop by 63% (Vega and Hidalgo, 2016). Ecuadorian and Colombian safety guidelines set basic parameters to assess buildings vulnerability, including the structure, material, height, age, conservation, soil, topography and layout. (Avila et al., 2016; UNDP Ecuador & SNGR Ecuador, 2012). Other approaches consider drainage, accessibility and community preparedness (Hernández Atencia & Ramírez Arcila, 2016). In fact, focusing on the exposure of different social groups to risks, beyond vulnerability scores, deepens assessments (Kim and Rowe, 2013). Furthermore, these assessments frameworks rely on experts' criteria in order to manage uncertainties (Du, Yin, Nadim, and Lacasse, 2013; Kaynia et al., 2008).

Form-based code compliance may be referential of the vulnerability of properties by reflecting consolidation levels based on density targets. Assessments show underused and vacant land suitable for safe development, relocations, or LRR downzoning. Attractive locations pressure for higher Floor-Area Ratios (FARs), often granted by weak city governments, potentially rising LR and DRM costs. Mechanisms such as value capture or the transfer of development rights (TDR) could reduce LR by protecting unsafe land, financed by the one suitable for development.

3.2. Socio-Economic Conditions

3.2.1. Land Value and Spatial Equity

Land value determines accessibility to safe housing and habitat. Lall and Deichmann (2009) assert that in well-functioning real estate systems, information regarding DR would reflect the attractive prices for the poor, which would be useful for DRM. Unfortunately, DR is not always reflected in price. According to Mansilla (2010), economic liberalization and decentralization in LAC, with the privatization of urban services has modified land prices, producing spatial segregation. Urban expansion in the Andes has reached slopes, with land becoming more expensive than in flatter regions, as in Medellín (Vidal, 2007). Unfortunately, only after a disaster strikes or

becomes imminent properties' values decrease, as in Moravia, Costa Rica (Fernández Arce, Méndez Ocampo, and Muñoz Jiménez, 2016).

If DR is acknowledged, investors, clients and owners would reconsider whether deciding to stay and upgrade or move. Amongst clients and residents, there are “climate deniers” who underestimate risk compared to the benefits of staying (Bunten and Kahn, 2017), reflecting unreliable land price differences. In developed countries, competitive development firms—through marketing and self-reliant climate adaptation—get overpriced their risky assets (Teicher, 2018). This could vary in Latin-American contexts, considering the informal markets of risky land.

3.2.2. Captivity to Risk

Lall and Deichmann (2009) state that families in DR are forced to choose between coping with, mitigating or transferring risk. Impoverished households are forced to cope, because they need to settle near employment, education and opportunities, which condemns them to endangered space, between infringement and regularization. This risk is reproduced when building for the offspring, and capitalized with useless mitigation measures in what Allen et al. (2017) call “risk traps”.

Methods of risk transfer include renting or selling. Another transfer mean is property insurance, which is uncommon. Other public or partnered finance-based LRR measures include poor-quality neighborhood upgrading, retrofitting and relocation, the complexity and impacts of which outweigh investments. However, successful relocations require careful social involvement and sensitive management.

3.2.3. Community willingness to invest in LRR

LRR interventions can be hard or soft. The hard measures, such as massive relocation, are perceived as being most effective. Although soft measures, such as social media use, are often used for preparedness and response they are still perceived as helpful (Bustillos Ardaya, Evers, and Ribbe, 2017). Hard measures include actions from retrofitting expenses to complex land–capital transactions. Nonetheless, community organization, willingness and civic training are required for this. Commonly, households' willingness depends on the operation type (retrofitting, relocation), bonuses, loans and relocation places offered by LRR operators.

Neighborhood upgrading and housing retrofitting are pragmatic LRR solutions. House owners prefer thorough retrofitting, compared to apartment renters, who prefer low-cost, temporary retrofitting (Gupta and Gregg, 2012). This heterogeneity depends

on the targeted socio-economic groups and their preferences, access to roads, the use of social networks or trust in governments (Baert et al., 2019). Moreover, piecemeal approaches fail in LRR. In Lima, Peru, mitigation investments separately involving inhabitants, state and external agents worsened in confronting the underlying factors of risks (Allen et al., 2017).

For small-sized DRR operations applying risk-sensitive LUP evidence shows the importance of education, communication, community participation and innovative private sector involvement through incentives, regulations and governmental leadership (Hung, Yang, Chien, & Liu, 2016; Sudmeier-Rieux et al., 2015). Moreover, the use of soft measures is recommended over complex relocations (Arlikatti, Maghelal, Agnimitra, and Chatterjee, 2018).

A supportive legal basis is recommended for complex relocations and expropriations, alongside public infrastructural investment. In-situ relocation within neighborhood upgrading with community participation are iconic in Medellin, which increased habitat quality, regardless of the drawbacks and challenges (Garcia Ferrari, Smith, Coupe, and Rivera, 2018; Vidal, 2007).

3.3. Socio-Cultural Factors

3.3.1. Root Causes and Social Construction of Risk

Oliver-Smith, Alcántara-Ayala, Burton, and Lavell (2017) assert that social perceptions, needs, demands, decisions and practices contextualize disasters. Commonly in this materialization, social economy prevails. In this context, Little (1981) determined a colonial trend in the eastern Andes: inappropriate exploitation of erosion-sensitive soils before abrupt climates, producing landslides.

Alongside, private actors prioritize profit and transfer risk. J. P. Sarmiento et al. (2015) evaluated Santiago (Chile) and Bogota's (Colombia) private participation in DRR. They found overall disdain in companies by lacking business continuity plans before risks and devoid of social responsibility towards workers and community. Entrepreneurs claim for incentives while weak regulations persist, with exceptions.

Promptly, the forensic investigation of DR (or FORIN approach) seeks root-causes of risk beyond shallow conditions. Unsafe urbanization is a social construct, shaped by incentives and constraints driven by deeper processes—human activities and mobility—and rooted in structural causes—skewed development—producing “risk societies” (Alcántara-Ayala, 2019; Burton, 2015; Oliver-Smith et al., 2017). Social

vulnerability and exposure are critical for territorializing disasters, as found by Hoyos, Escobar, Restrepo, Arango and Ortiz (2013) in the Colombian 2010–2011 La Niña phenomenon aftermath.

In LAC, self-building is scarcely and unevenly followed by statal aid. In La Paz, Bolivia, governmental assistance for slope-adaptation lacks in the northern poor, contrasting to the southern wealthy (O'Hare and Rivas, 2005). Bolivian cities exhibit a peri-urbanization in LR due to migration. Quito, in Ecuador, accumulated an unattended economy, urban growth and poor planning, producing slopes occupancy, with costly provision of services, inappropriate waste disposal and drainage in ravines, causing landslides. Additionally, Colombia's urban LR increased alongside its socio-political unrest (Hardoy and Pandiella, 2009). Even worse, self-built Latin-American settlements confront permanent environmental and eviction pressures, eventually producing unsustainable habitats, the costs of which outweigh short-term survival (Murillo, 2012).

3.3.2. Constructivist Value of Risk

People perceive risk asymmetrically. Their behaviors ignore increased future risk, while experts strive to understand this complexity (Sou, 2018). A bias in perception is the "risk homeostasis": a self-convenient underestimation of risk after prevention/reduction. Furthermore, the "social amplification/attenuation of risk" determines personal magnitude of risk. Risk perception (RP) are assessed through blame, trust, prior attitudes, heuristics and affective imagery, framed by communication (Etkin, 2016). People overestimate and underestimate risk. Therefore, perception management enhances LUP for LRR. Constructivist views interpret particular, complex and contradictory socio-political realities in producing and managing risk. This, complemented with naturalistic/rationalist interpretation of hazards, can help in reducing uncertainties (Rebotier, 2016)

An LR study in Rio de Janeiro, Brazil, found perception is influenced by experience and demographics, followed by civil society, and less by government, unreliable by communities (Bustillos Ardaya et al., 2017). People prioritize social, cultural and economic processes over incumbent DRR. However, building codes are acknowledged as good-practice references. In Cochabamba, Bolivia, self-built areas' dwellers dimly prioritize housing over risk, with scant governmental assistance (Sou, 2018). In La Paz, landslide-endangered inhabitants underestimate risk, confounding it

with disasters. Aymara culture denies risk with myths, resigning to nature's will and concealing household problems; mistrusting officials and misunderstanding experts (Nathan, 2008). The Andean Christians deliberately believe in divine protection or fate; Evangelists see nature as an object, Catholics as a subject and others as deities, such as the *Apus* (guardian mountains). This socio-cultural learning make dwellers what to fear, within multi-stakeholder environments, corruption, incompetent governments and politization of science (Bolaños-Valencia, Villegas-Palacio, López-Gómez, Berrouet, & Ruiz, 2019; Lavell & Lavell, 2009; F. O. Sarmiento, 2009; Scoville-Simonds, 2018). Chosica, in Lima, portrays RP through iterative spatial knowledge, risk prioritization, normalization and tolerance towards others, reflecting planning as political (Miranda Sara, Jameson, Pfeffer, and Baud, 2016).

Successful LRR practices include the “Guardianes de la Ladera” and “Biomanizales” in Manizales, Colombia, where female heads of households managed knowledge dissemination with community-based accompaniment, considering social vulnerability, shared responsibility, microfinancing, employment generation, empowering marginalized groups and pairing top-down and bottom-up approaches (Coles & Quintero-Angel, 2018; Lavell & Lavell, 2009). Additionally, the Tiwanaku culture adopts traditional knowledge for clay slope reinforcement and erosion control using *Penca* cactuses (Margottini, Canuti, and Sassa, 2013b).

3.3.3. Informal Urban Settlements

Low-cost, spontaneous and service-deprived settlements in LAC comprise 40% of total housing, related to migration and urban poverty; however, not all informal residents are poor (Klaufus and van Lindert, 2012). Informal settlements locate often on hazardous land (Jiusto, 2012). Informal space interacts with state power and capitalism. Informality compensates failures of formal economies and it is self-regulated (Gonzalez, 2009; Murillo, 2012; Roy, 2015).

Planners–community communication are crucial when managing risky informal settlements, where unawareness is common. In La Paz, with a 60% self-built home rate, landslides are between the most damaging hazards (Latrubesse, Baker, and Argollo, 2009). Unfortunately, the understanding of the importance of DRR regulations does not reach low-skilled workers and most self-build owners (Chmutina, Rose, Shrestha, and Bhatta, 2018). Regardless of new codes, achieving compliance in the existing and new informality, remains a challenge (Ahmed et al., 2018).

In this interaction, land rent must benefit the neediest, through housing state facilitation, adapting the demands of informal sectors (Jaramillo, 2008). For instance, TDR could be granted to conserve risky land, retrofit or demolish buildings at risk. In LAC, Turnerian regularization or sites-and-services programs have linked informality to cities' economies. However, slums continue growing (Klaufus and van Lindert, 2012); therefore, the LR. Two regularization examples granted tenure, easing the provision of services, formal loans and ownership transfers. They were the Commission for the Formalization of Informal Property (COFOPRI) in Lima (Klaufus and van Lindert, 2012), and the regularization units in Quito (Gómez Salazar & Cuví, 2016). These cases illustrate the remark of Romero-Lankao et al. (2014, p. 224) related to the power of informality in exceeding laws and planning, impacting on risk production and management

In Ecuador, urbanization density is positively related to deprivation and overcrowding (Obaco, Royuela, and Matano, 2020); paradoxically, informal residents are motivated to densify to access services to enhance their living standards. In any case, regularization is likely to continue. Its beneficiaries are potential losers, as with the cities themselves, and it is not clear what they receive in exchange for the burdens of informality. In contrast, pirate developers clearly benefit by easing access to land, as in Ciudad Bolívar in Bogotá (Gonzalez, 2009), with deferred charges for residents and cities. In Quito, informal developers illegally subdivide former rural land using a legal tool called “derechos y acciones”, which provides ownership as an intangible percentage of the whole. In squatters/invasions, owners (often, the state) are aggrieved while invaders gain possession.

In the Andes, the informal always follows the formal, and residents must coexist with both and shape them safely. Many urban adaptations to “sites-and-services”, as well as formal–informal hybrids are more realistic than condemning informality. However, including LRR in regularization is also realistic and promising, currently pioneered by Medellín.

3.4. Policy and Institutional Factors

3.4.1. Risk-Sensitive LUP (RS-LUP)

Compliance with LUP help reduce exposure to hazards, particularly for preservation zones with limited development (Kim and Rowe, 2013). In the Andes, recent contributions for RS-LUP, include layout and density restrictions, building

system usage and the settling of road gully crossings, early warning systems (EWS) and structural mitigation, as for the debris flows of Abancay (Peru) and Tarapacá (Chile), Medellín's landslides and the Peruvian Cordilleras (Rodríguez-Morata et al., 2019; Vega & Hidalgo, 2016). Ecosystem-based approaches efficiently support DRR within contexts of liberalization, land consumption and socio-environmental threats (Sudmeier-Rieux et al., 2015).

LAC countries are incorporating LUP into their legislation (Montandon and Rossbach, 2017). Currently, LUP in LAC is mostly a local responsibility (Massiris Cabeza, 2012; van Lindert, 2016). Some national laws in LAC address specifically urban planning, being the Guatemalan and Chilean the oldest. Colombia (1997) and Brazil (2001) pioneered in urban management laws, exceeding the prescriptive planning. The Ecuadorian LUPM law is the latest (2016) and Ecuador is envisaging a DRM law. Coherent with their context, the Colombian, Ecuadorian, Peruvian and Mexican urban planning laws, address DRM, safety and climate-related events (Montandon and Rossbach, 2017).

The Latin-American dichotomy between planning and management is a key problem, overcome in other countries. For success, planning requires participation from community, private and public planning-related sectors, considering incentives and ecosystem-based approaches. Likewise, implementation requires robust institutions as planning and stakeholder involvement promoters (Sudmeier-Rieux et al., 2015).

3.4.2. Land and Urban Management

Public or partnered land management (LM) aims to implement RS-LUP, supported institutionally, legally, with built-in capacity and budgetary backing. Oftentimes this is not the case. In Mt. Elgon, Uganda, an LRR implementation assessment revealed institutional vulnerability, with inadequate financial and human capacity, political interference, misuse of resources, poor participation and no legislation, resulting in the poor policy enforcement (Masaba, Mungai, Isabirye, and Nsubuga, 2017). LM start-ups face unexpected challenges. Benin's land law implementation failed, because it overlapped with old systems, while ignoring alternative access to land (Ekpodessi and Nakamura, 2018).

LM is a component of the 1986's UN/WB *Urban Management Program* (UMP), which shifted from housing provision policies to holistic urbanism by incorporating local

governance and financial management, infrastructure, land and environmental management and poverty alleviation (van Lindert, 2016). UMP actions included land regularization and sites-and-services programs. A critique, however, was its clientelist-like problem-solving (Jiusto, 2012).

Cusco's (Peru) Urban Risk Assessment, a WB tool, highlighted the city's social adaptability, migration trends, tourism dependence, informal settlements participation, data scarcity and CCA as noticeable traits for LRR management, which, wisely, was first disseminated in institutions (Bloch et al., 2014). A similar assessment of the climate-related resettlements of the Bogota Humana program revealed uneven geographies and the resistance of residents, because their real needs were unattended, e.g., legalization and fair compensation (H. Sarmiento, 2020).

Matching scientific-governmental top-down with community bottom-up approaches supports sustainability. This was the case in the MoSSaiC project in Saint Lucía, outstanding in LAC (Holcombe et al., 2013). Similarly, the Favela-Bairro program in Rio de Janeiro, fostered community initiatives, producing landslide-preventive adaptations, improved and secure spaces, participative implementation, microcredits and utility provision (Murillo, 2012). In the Andes, the iconic Medellin, treats slopes in a low-tech, low-cost, community-based, scalable and landscape-based pilot project, including EWS, drainage, micro-farming, foresting and sites-and-services (Claghorn and Werthmann, 2015). Medellin's Urban Development Enterprise (EDU) integrates planning units to implement urban regeneration, facilities and service delivery projects, involving community through public-private partnerships (Garcia Ferrari et al., 2018). Alongside the Valle de Aburrá's economic forces promoting forest depletion and cumbersome geophysical and building conditions, as noted by Margottini, Canuti, and Sassa (2013a), Medellín and its valley succeeds through multi-level risk governance networks, ecological and open space planning, social capital and innovation, civic engagement, public-private partnerships, education and esthetics (Corburn, Asari, Pérez Jamarillo, & Gaviria, 2020; K. Frey & Ramírez, 2019).

Finally, the "mancomunidad" tool—an association of local governments—has proven efficiency in Ayabaca's (Peru) DRR in roads through co-financing and multi-sourcing (Lavell and Lavell, 2009). Ecuador's legislation includes "mancomunidad" tools for multiple purposes, resembling the traditional "mingas"—a cooperative work performed by all community members—but scaled up to regions and co-financed with national budget.

3.4.3. Politics and LRR Policies

Political will is a major determining factor in framing DRR policies, potentially overriding other actors' stakes and the general interest. LR becomes a burden for politicians facing community pressure, but an asset when they make decisions regarding LRR solutions.

These assets may help incumbent politicians get reelected, as occurred after the 2010–2011 disastrous rainy season in Colombia. Gallego (2018) states that the aid resources rewarded the incumbent politicians with electors' votes. This pervasive practice was seized upon by illegal armed groups in the internal conflict; according to Hoyos, Escobar, Restrepo, Arango, and Ortiz, (2013), this motivated informal settlements in urban risk areas of socially vulnerable victims of the conflict. Similarly pervasive is the collusion some incumbents and community leaders against safety and nature by regularizing neighborhoods in landslide-prone and ecologically-sensitive areas, such as in Quito (Gómez Salazar and Cuvi, 2016). In Cuenca, Ecuador, the wealthy in illegal settlements infringe the clearance of slope setbacks in light of lax ordinance enforcement (Serra-Llobet and Hermida, 2017).

3.5. Operational Table for the Framework

The operationalization of the factors listed for each of the four dimensions is shown in **Table 1**, considering the development from concepts to either qualitative or quantitative factors. Suggested instruments, as well as sources, are also proposed, which may vary according to the local conditions of data sources.

1 **Table 1.**

2 Operationalization of dimensional concepts in research on land policies for landslide risk reduction. By the authors.

Dimension	Concepts	Factors	Descriptors / Ordinal Categories	Instruments / Survey + Processing Method	Sources
Built and Natural Environment	Landslide susceptibility Climate Change Adaptation	Susceptibility CCA Actions	Susceptibility score → Deniers/ignorance → Knowledge → CCA Actions	GIS modelling Specialized reports, Interviews	Local security secretariat Environmental departments, community
	Physical Vulnerability	Building Vulnerability to Landslides evaluation (BVL), seize of the FAR Land values	BVL Scores, FAR compliance	Field Survey, observation /GIS calculation / drone flight	Fieldwork, Local cadaster
Socio-Economic	Land value	Land values	Land Value	Cadaster database building and processing	Property registry, cadaster, consultants
	Captivity to risk	Risk transfer level	→ Coping risk → Mitigation → Risk transfer	Perception survey / focus groups / semi-structured interviews / file collection	Fieldwork, community, property registry
	Willingness towards mitigation projects	Community willingness to participate in large mitigation projects	Willingness index	survey / interviews / focus groups	Fieldwork, community
Socio-Cultural	Social Construction of risk	Socio-economic vulnerability	Socio-economic vulnerability index	Survey / interviews / focus groups	Fieldwork, community, census database
	Constructivist Value of Risk	Level of risk awareness	→ Ignorance → Awareness → Action	Perception survey / focus groups / semi-structured interviews	Fieldwork, community
	Informal settlements	Level of formality	→ Informal subdivision → Informal building → Formality	File collection / interviews	City archive, city officials, community
Policy-Institutional	Risk-sensitive LUP	State of development of planning	→ General plan → Local plan → RS-LUP	Desk research / interviews / file collection	City archive, city officials
	Urban management	State of development of executors	→ No agency → General agency → Task force	Desk research / interviews / file collection	City bylaws, city officials
	Politics and LRR policies	Politicians attitude regarding LRR	→ Clientelism → Disdain/Neutral → LRR Proactivity	Interviews, focus groups	Community, experts, local officials

3

In order to understand the application of this framework, an example of a case study in the Andes region is shown below.

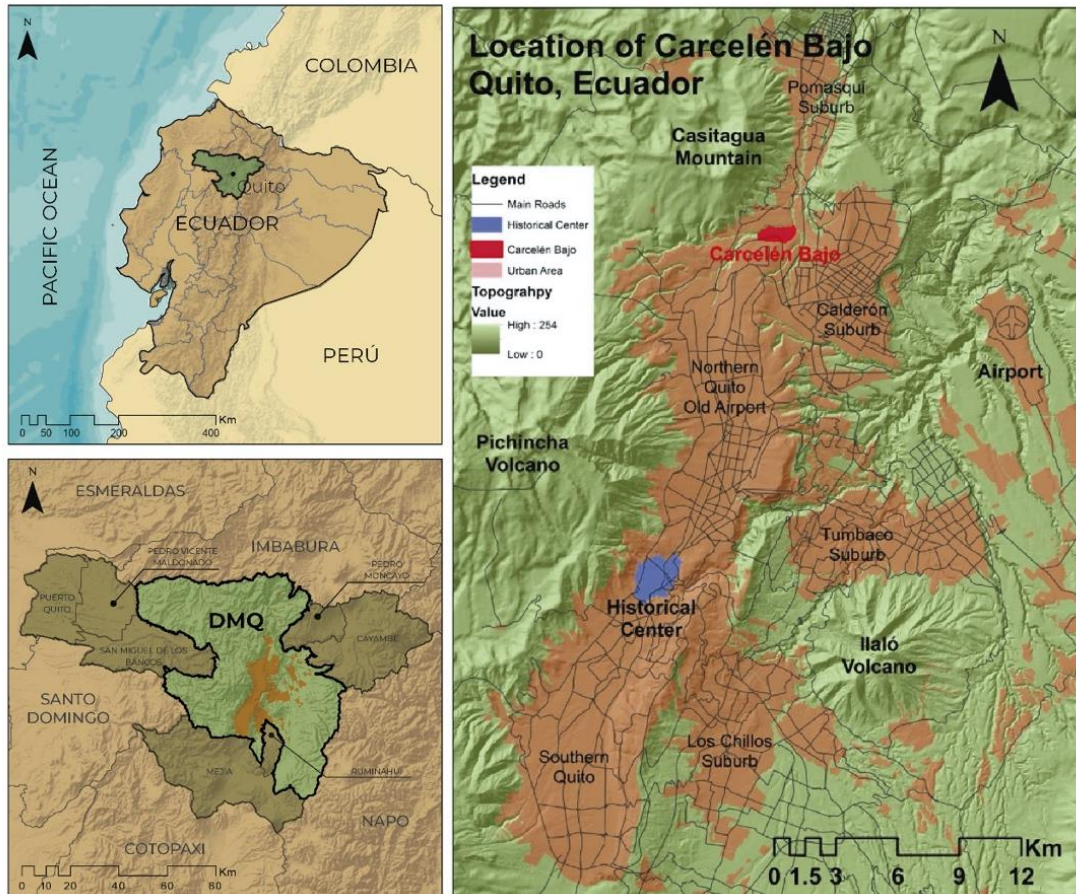
4. Application of the Framework to a Case Study Site

4.1. Site profile

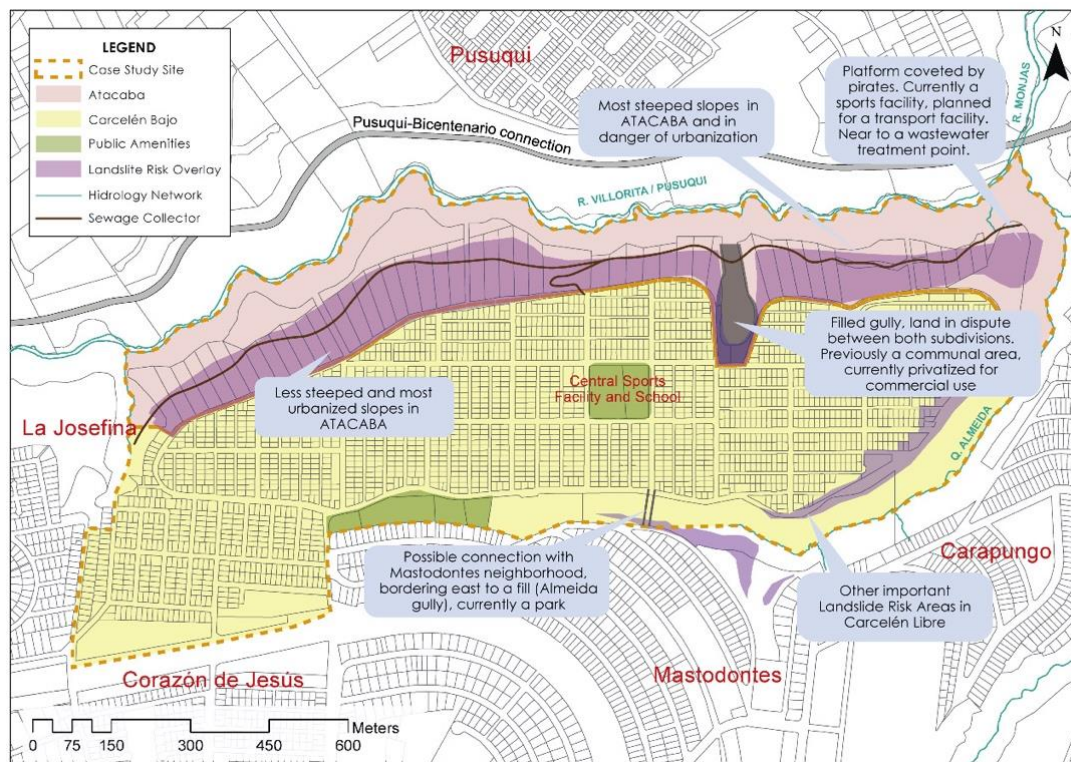
The Carcelén Bajo Study Area (CBSA) is a large, peri-urban neighborhood in the northern part of the city of Quito, Ecuador (see **Figure 2a**), which by last census held in 2010 registered 12537 inhabitants (INEC data) with an urban density of 220 people/ha and an urban consolidation of 85%. Nearly 2510 people were poor and 527 extremely poor, according to unsatisfied basic needs, 4359 are economically active, with a 3.1% unemployment. However, the access to professional degrees in order to obtain better job positions is limited. Basic services have important coverage, but public amenities are scarce (Aguilar, 2011; Narváez, 2012).

CBSA began as a housing cooperative in the 1970s within a large proposed subdivision called “Carcelén Libre” (CL) in a natural platform surrounded by slopes, ravines and a river. Its social organization has a history of informal settlements, deprivations, internal conflicts combined with political clientelism. It was formerly composed by migrants from Ecuadorian northern provinces and currently, it deploys continuous renovation of social organization, including youth groups, often mistrusting authorities (Aguilar, 2011; Narváez, 2012).

It is under discussion whether the north embankment was formerly transferred or not to the municipality for ecological protection. Years later, some of the CL cooperative board members gained approval for a new subdivision in this protected embankment (called “ATACABA”) in favor of a retailers’ association in the vicinity—apparently, through an irregular yet official action, according to former officials. The municipality partially recognized the right to build in this area. Recent studies determined that ATACABA, as with other CBSA margins, is highly susceptible to landslides (Merino, 2018; Ormaza, 2017); since 2011, there is a LR zoning restriction for buildings unless mitigation is demonstrated. In CBSA, dozens of landslides have occurred, and more are expected.



a.



b.

Figure 2. a. Location of the Carcelén Bajo Neighborhood in Quito, Ecuador. b. Carcelén Bajo main features. Source: Quito Municipality, adapted by Fernando Puente and Valeria Rivera.

To understand the current conditions of this case in relation to landslide reduction, the multidimensional framework presented above will be used for characterization. This is explained as a narrative; later, we discuss the interrelation between dimensions. This example briefly presents results which facilitate the understanding of our framework.

4.2. Operationalization instruments and sources

A single-case study methodology was applied for this research. Descriptive data were collected from the municipality and reprocessed by the researchers. Most of the collected information was qualitative, and triangulation was applied between the following sources of information:

- Eighteen community members were interviewed as follows:
 - Three members from CL in a group session;
 - Seven members from ATACABA in a group session;
 - Two members in four different focus groups as part of a larger study (six people from other sites in the city in each group).
- Seven municipal officials were interviewed in six sessions;
- Fifteen experts were involved in a panel discussion with 60 public attendees;
- Revision of municipal and national public documentation, datasets and normative pieces; traditional, official and social media; and academic works and archives;
- Seventy-nine survey questions were asked to informants—mostly owners—from 324 at-risk properties and collected by research students.

4.3. Collected Results for each Dimension

The following sub-sections analyze the case according to the conceptual framework presented in section 3.

4.3.1. Environment: The Colonized Arid Banks

Landslide Susceptibility: Witnessed and Expected Events

Municipal records and studies show that the northern banks of CBSA have high and very high susceptibility to landslides, which partially matches the landslide risk zoning set in the LUP for the area (see **Figure 3**), in which three events occurred between 2005 and 2017 (Puente-Sotomayor et al., 2020). This seems to be an

under-record, because the interviewees witnessed more landslides in recent years, including house collapses, and expect further landslides due to increased self-building, inappropriate soil management and overloads and climatic variation. Such increment is proven by the registry of 83 events, including 26 rotational slides, 21 falls and 36 flows, surveyed by Ormaza (2017).

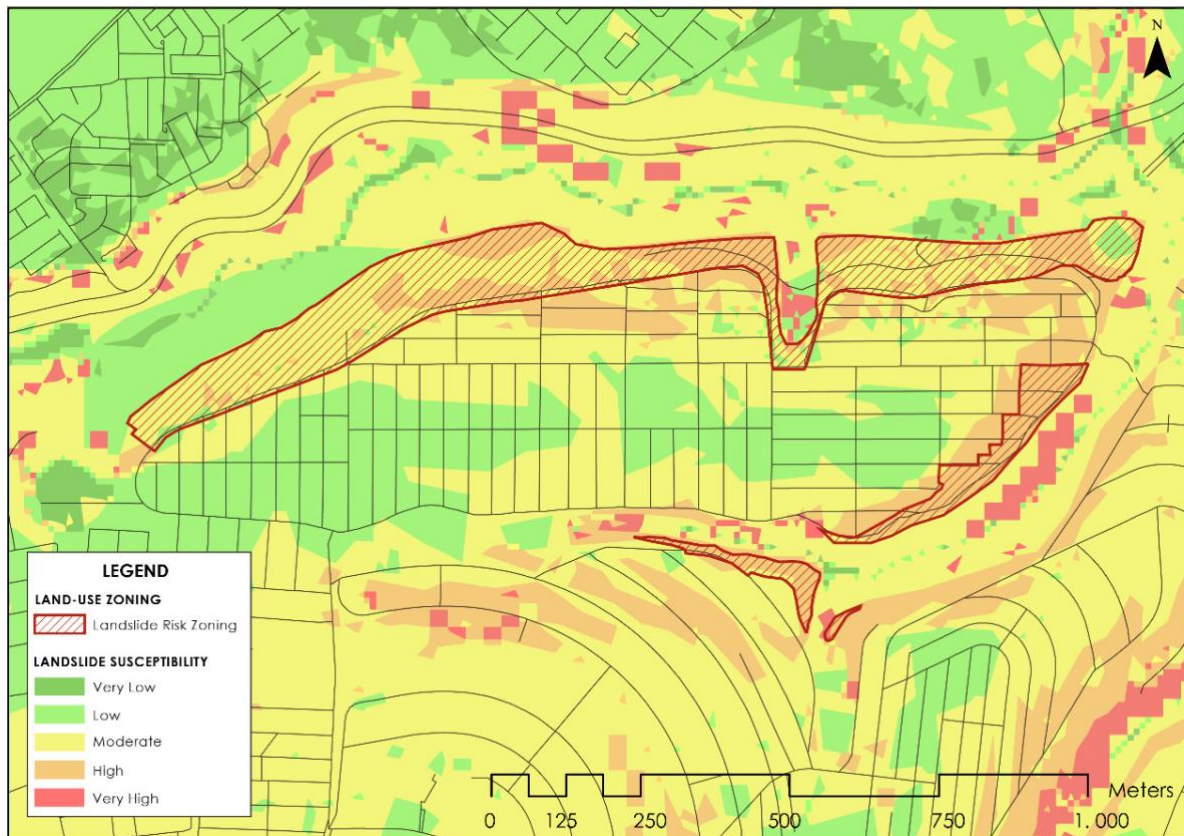


Figure 3. Carcelén Bajo landslide susceptibility map and risk zoning. Source: MDMQ. Adapted by Valeria Rivera

In ATACABA, some owners were allowed to fill their lots with construction debris to create embankments, which result unsafe due to the soil quality (sand in a semi-arid microclimate), steep slopes and climatic variations (intense precipitation and extremely dry and windy seasons). Rainy periods reveal the vulnerability produced by the filling-in of gullies, the material for which often originate from construction debris. This was the case in the gully located in the site in dispute between ATACABA and CL, set in the northeast of the central stadium and school of CL (see **Figure 2b**).

CCA: Two attitudes

No extreme climatic events have been perceived by interviewees. However, according to INAMHI (National Meteorology Institute), Quito accumulated precipitations of 565.3 mm during January, February and March in 2017, compared to the normal 336.3 mm from previous similar periods and erosion has been registered in eastern CBSA (Merino, 2018). Both factors would lead to further landslides. In light of this, CL leaders are conscious of greening slopes and propose reforestation with schools' support. They understand the importance of endemic species for the retaining of soil and slow drainage. In contrast, ATACABA residents refuse to accept that landslides may arise, considering previous low occurrence, which are actually imprecise. Universities have evaluated their landslide risk and proposed slope greening. Unfortunately, residents maintain a utilitarian vision of the land before LRR and argue against greening for the reasons of aridity and water. Moreover, they propose that the extracted earth from the subway should fill their gullies.

Meanwhile, the municipality holds a fragmented position about CCA. The environmental department supports research into the impacts of CC and its adaptation measures, but they struggle to integrate other departments into developing effectiveness. The LUP department diverts CCA initiatives into “*green wash*” norms that ultimately benefit real-estate developers, as in the eco-efficiency code, as stated by officials and experts.

Built Vulnerability: Null Enforcement

Illegal construction follows illegal plots. CBSA respondents and district officials indicated that the residents of the slope areas disrespect municipal codes. In the risk area, 83% of the properties score a medium level of vulnerability to landslides, while the rest scored low vulnerability, according to national evaluation guidelines. Additionally, the municipal cadaster showed that nearly 30% of buildings corresponded to a low use of the FAR code, 50% approached it, 20% reached it and 5% surpassed it (Egas, 2018; UNDP Ecuador and SNGR Ecuador, 2012). Therefore, downzoning with compensation measures may reduce landslide risk.

4.3.2. Socio-Economics: Misleading the Naive Poor

Land Value: Market Circumvents Risk

A reference level to understand CBSA property values is the US\$400/month minimum wage in Ecuador. According to the Quito Municipality (MDMQ) and the Ecuadorian Association of Properties Prices Surveyors, a typical 170 m² plot in CL costs between US\$110 and US\$150 per m², while in ATACABA, a typical 4000 m² plot costs between US\$35 and US\$50 per m², approximately. The difference relates to the dense commercial center in CL, while ATACABA, regardless of its proximity to the CBSA center, lacks decent accessibility and remains as at-risk area.

Interviewees stated that some owners of major plots (around 4000 m²) in ATACABA have subdivided them, promoted—even via the Internet—and sold in smaller plots (around 400 m²) at attractive prices (US\$2000 to US\$3000) on dangerous land to naive poor people without legal deeds. Sub-dividers ask for a 50% advance payment before regularization, which remains pending. Meanwhile, illegal occupants are continuously charged for endless paperwork.

The private sector in CBSA is absent; no industries or major commercial companies are settled there. Municipals stated that private developers are not attracted to the area, due to its informality. Banks would not grant any loans based on the illegal tenure of land, which condemns the residents even further.

Captivity: No Place to Go

Often, hazardous properties are occupied at very low rental values. Abandoned houses are even invaded; in one case, an owner was evicted by invaders. Renters are needy migrants such the northern Afro-Ecuadorian ethnicity and indigenous from the *Sierra*. These occupants ignore the legality of their land and its LR. Venezuelan migrants are new captives of LR. Coherently, Álvarez (2018) has identified central Carcelén as a major commercial pole attracting Venezuelan migrants, who cannot find cheaper places to live, and must overcrowd houses. Thus, LR is transferred to these recipient groups; otherwise, landlords prefer to sell their properties.

Insurance risk transfer is inaccessible for occupants in LR due to the cost, uncommon use and limited offer. However, the municipality has insurance

coverage in case of disasters produced by works such as the wastewater collector built in ATACABA slopes.

LRR Willingness: What is Offered?

CL leaders often call for *mingas*, traditional communal work events that have helped build green space and health service amenities (Andrade, 2011), using loudspeakers and recently on social media. Some of these events aim to mitigate LR. Unfortunately, once people obtain basic services and pavement, they ignore *mingas* and focus on their individual needs. Formerly, all residents knew each other and cooperated; our interviewees stated that, currently, only sports associations, dance groups, and the priest cooperate.

People have an attachment to their place, because many built it from scratch, and their offspring produced the existing structures. Therefore, they prefer to reinforce/mitigate properties rather than relocate, unless a convenient place is offered. Survey results show that almost 80% of the owners would prefer embankment reinforcement than relocation or inaction. However, slightly more than half of residents are barely or not interested in relocation, while slightly less than half would accept relocation under recognition of their existing asset, plus a \$5000 bonus. This calls for the need of sharp analysis of relocation sites, counteracting price speculation through strategic land management, while providing served plots (Egas, 2018). Interviewees stated that almost 10% of hazardous plots in ATACABA belong to former sub-dividers, who transfer risk by selling but keep the safest properties.

Relocation in *Victoria del Sur*, *La Mena 2* and *Bellavista de Carretas* housing projects in Quito has not been satisfactory. The municipality has no structured DRR actions for CBSA. However, residents are willing to defer in annual payments if the authority invests in vital retaining walls. CL leaders say landslides have been frequent, but that people currently hide disasters, as they could fear eviction or could be compelled to lose their rights for reducing risk.

4.3.3. Socio-Cultural: Risk Capitalization and Determinism

Root-Causes: Producing Risk in the Basin

A renowned social-housing cooperative bought the CBSA platform, generating two major subdivisions: CL (55 Ha.) in 1985 and ATACABA (32 Ha.) in 2006. Both areas' promoters were required public works and communal spaces to be finished

before municipal delivery of plot deeds. Former CL leaders claim that some colleague members had privileged knowledge and influenced the approval of ATACABA while having shares in both subdivisions. Plaintiffs stated that ATACABA was a riverbank protection area of CBSA, transferable to the city, according to the law in force in the 1980s. However, in practice, it was approved separately, presumably on purpose, as an independent subdivision. The municipality recognizes the vagueness of the approvals but finds no solution after failed mediation boards led by council members. CL leaders say that their ATACABA colleagues even attempted to co-opt them to join in with the collusion. Furthermore, they accused an ATACABA leader of having invaded a CL public space and manipulated its purchase, where no clear boundaries existed between both subdivisions. Meanwhile, earthworks occurred in ATACABA's major plots to enable smaller subdivisions. The CL plaintiffs received no resolution, while production on landslide-prone land increased, benefiting pirate developers.

In contrast, ATACABA defend their subdivision's legality—not as invasion—although they recognize having understandings with the municipality and awaiting regularization of minor subdivisions. Before that, ATACABA keeps refusing to finish works such as stairways, considering them unfeasible, proposing forestation instead, which is counterintuitive while they build on the slope (see **Figure 4**). Additionally, the city built a wastewater collector, splitting the slope lots with a road, that prompts development and, therefore, LR. Nonetheless, residents complain of broken municipal promises regarding bettering the neighborhood.

Internally, conflicts such as unclear parcel tracing and puzzled social organization, are remarkable; some accuse others of invading public areas and performing earthwork illegally, particularly in western plots. New invasions threat north-eastern CBSA, where a sports field, a wastewater treatment point, and the site for a planned bus station converge in a strategic location next to the express road network. Logically, ATACABA is requesting the allocation of this area. The conflicts have reached aggression, with organized defenses of the occupation. Apparently, their *modus operandi* has been crowded invasion and subsequent lobbied regularization, while denouncers of LR production in CBSA are stigmatized by their peers. The problem is rising, and inaction is common at all levels.



Figure 4. ATACABA banks from across the Villorita River (north limit). a. View towards the east. b. View of the central plots. Photos: Fernando Puente-Sotomayor

Constructivism: Whatever Happens...

More than two-thirds of the at-risk owners perceive being at a low or very low risk, despite 60% inhabiting LR areas. Egas (2018), relies this unawareness on the lack of knowledge dissemination about the site conditions. In detail, residents of landslide-prone areas in CBSA have a deterministic vision regarding LR. They feel conformity with a potential fatality, or they trust in divine protection. They prioritize other problems, such as street vendors conflicts, a lack of transportation and road connection to expressways, internal racism and stigmatization by other neighborhoods, uncontrolled urban fauna, contamination, drug micro-trafficking and emerging delinquency; fortunately, the latter is somewhat controlled with satisfactory coordination with the police.

Informality: Self-Built Risk

Some residents in CBSA now build wisely, with professional management and abiding controls. However, most dwellers self-build using untrained masons and make illegal connections to services, potentially producing underground tunneling and subsidence. In ATACABA, more than two-thirds of the plots declare having deeds, but only 7% declare having building permits. Commonly, once owners obtained plot deeds they built without permits (Egas, 2018). Furthermore, another stated cause of construction failure is the quality of steel and grit.

Municipals regret that their control agency has lost capacity, which has been politically deliberate. Current patrols are demand-based rather than programmed. Even state housing has ignored code enforcement. Most people expect the regularization of subdivisions and buildings; however, they also expect technical

advice for realistic LRR measures. During the last decade, massive amounts of buildings were regularized. However, self-building has accelerated recently after new roads appeared, interviewees said.

Paradoxically, the failed regularization of subdivisions and buildings has decelerated its growth, officials stated. Before 2010, it was possible to sell public space to its invaders, but after the approval of the Ecuadorian Organic Code of Territorial Organization, Autonomy and Decentralization (COOTAD), this was no longer allowed. However, some evictions have been blocked at the political level. A reform of this code, in 2014, strongly penalized regularization of settlements at risk. This reduced clientelist intermediations of politicians advocating settlement regularization, underestimating LR.

4.3.4. Policy-Institutional: Formal Gaps Fostering the Illegitimate

RS-LUP: Piecemeal Planning

Quito approved a zoning ordinance banning construction in LR areas in 2011. This was relaxed in 2013, under the justification of mitigation. Meanwhile, landslide susceptibility studies finished in 2015 and are expected to update the plan in 2020. ATACABA leaders have persistently lobbied to expand the urban limit to partially include minor lots for medium-density residential use. Although some land-use changes have favored ATACABA, supported by council members, the municipal technical view has defended the protection of the slopes, resulting in a “mediated” map seen in **Figure 5**.

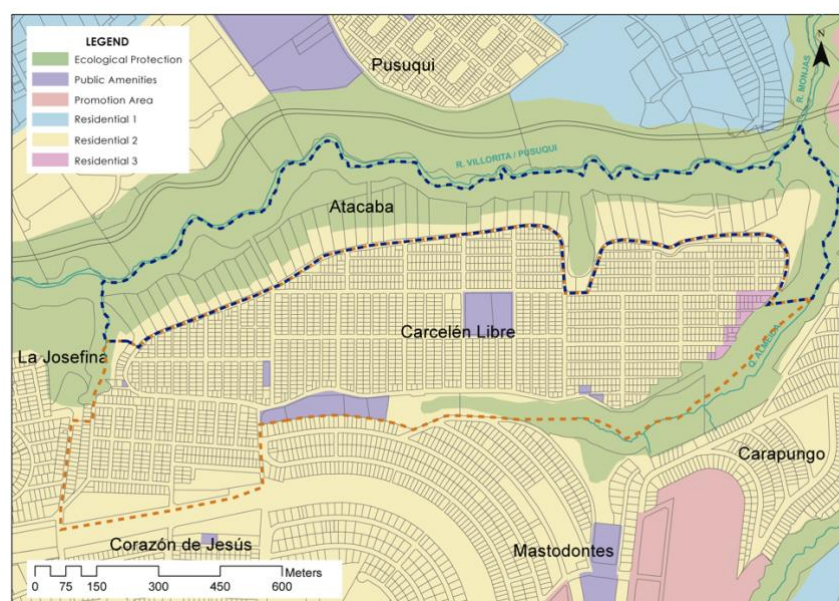


Figure 5. CBSA LUP. In ATACABA (north,) medium-density residential (2) zoning has been granted to the plot areas closer to CL. Source: Quito Municipality. Adapted by Valeria Rivera

ATACABA started as approved agricultural/ecological land but changed its southern margins' land-use pressured by of informal urbanization. Academic and official technical recommendations include slope greening and water recycling, but residents are skeptical to this advice, defending the utilitarian interest of housing and arguing that the soil is arid. On the other hand, CL residents express regret that even municipal engineers deny the existence of LR.

Risk Management: Piecemeal Actions

There are no structured LRR programs in CBSA. Similar to the EDU from Medellín, Quito started an urban development enterprise in 2008. Its housing division was transferred to a new housing enterprise in 2010, which struggled to maintain an LRR relocation program, in which families accessed new housing units by providing a deposit, complemented by public bonus and credit. Currently, both enterprises have declining performances, officials say.

Participatory budgeting aided in the shallow stabilization of some critical slopes. Residents consider this to be insufficient. Municipal desk planning is seen as having no impact, while officials find it useful regardless of the limited capacity. Furthermore, CL leaders regret they can no longer demand public works in smaller groups, because an ordinance reform currently requires at least 50% of the subdivision members to have signed petitions. Co-financed projects (50% municipality–50% community) are no longer active. This shows the fading mutual understanding between the municipality and the community. However, the municipality is willing to provide works to those with deeds, and has even provided works beyond the confines of legality.

CL operate through *mingas*, which currently lack member support, commitment and cannot solve LR problems. In contrast, in terms of waste collection, roads and public facilities, *mingas* may potentially exacerbate LR, regardless of their evident benefits. Traditional media has been useful for LRR in specific cases, but this has not been sustained in the long term.

On a positive note, the role of women is remarkable in leading social organizations. ATACABA highlighted the leadership and knowledge of a recently deceased lady president; CL's current president, a young woman, has been defined as a "flawless manager".

The blurry boundaries between CBSA subdivisions have caused a conflict over a communal space (see **Figure 2b**); in this context, the municipality embanked a platform over a gully in the center-north for open-air markets. Afterwards, ATACABA leaders completed earthworks and built and received a communal house as bailment, through provincial aid. CL claims that ATACABA used personal influence, but ATACABA interprets this as provincial support. Nevertheless, the allocation of that space to an ATACABA member, CL leaders claim, was also a result of influence peddling in the municipality. Similar influences were used for basic services for informal housing.

Our interviews show gaps in formal institutional and legal structures which are profited by pirate developers—presumably, leaders of ATACABA. Although officials and experts recognize municipal gaps and clumsiness, they also defend individual promoters within the institution who advocate for wise LRR.

CBSA residents say that politicians broke campaign promises and that they feel used. Their DRR and regularization needs are unsatisfied; after a decade of council members leading worktables, they have not finished solving the problem.

4.4. Discussion about the Inter-Dimensional Relations

In reference to the multi-relational framework illustrated in **Figure 1**, social components stand to play a major role in the amelioration/aggravation of the LR in CBSA. In order to succeed, the so-called “shared responsibility” requires the civic training of the community members who are willing to participate in LRR and awareness strategies to educate skeptical residents. Similar commitment is needed from public officials and other actors, including the judiciary, academia, media and private sector. From our literature review, it was found that natural scientists in Andean LRR fields increasingly recommend that land policies should be implemented with bottom-up approaches, as they have identified its benefits. In this regard, our case study presents a constructivist narrative built under triangulation techniques, beyond descriptive analysis of survey datasets, to deeply illustrate the problem and its derivations.

“The municipality” is not one actor, nor is “the community”. The same applies for other grouped actors, which is often a bias in actor analyses. There are nuances

across individuals and over time. In group actors there are specific individual promoters, antagonists and neutral members. Success in LRR is achieved by configuring an influential network of promoters across group-actors and overcoming the drawbacks of formal structures. Sometimes, this is simply impossible and needs alternative LRR strategies.

Urban risk generation in this case have proven that some normative reform practices improved LRR; however, others have worsened it. The penalization of the regularization of informal settlements on LR have stopped politicians from using risk as an asset. Furthermore, the allocation of invaded land on public areas is no longer allowed. Both reforms have deaccelerated LR production but has led to divided positions. The cost of opportunity is disputed between the benefit of land tenure for the poor versus LRR at the neighborhood scale. Both positions are antagonistic, and consensus remains a challenge. On the other hand, the “rights and actions” tool has been perversely abused to promote informal settlements and therefore LR by letting families access legally to a share of a macro-plot, but illegally subdivided and delimited. This leads to a large number of restrictions and conflicts, because of the responsibility to the rest of the owners of the same macro-plot. Unfortunately, this has been a common practice for decades and does not foresee any feasible solution to prevent LR production.

Settlers’ backgrounds explain their disdain regarding the risk of colonizing slopes, while other interests prevail, such as land tenure and access to the city. Informal settlers—and not only poor—have developed a *habitus* beyond legal limits based on the potential flexibilization of the norm lobbied by influential leaders, while also representing a leverage opportunity for politicians. LR could be reduced by downzoning accompanied with compensation incentives, particularly in the low-built area. LRR does not always mean costly retaining walls but could involve routine and long-term actions, such as greening, urban agriculture, technical debris disposal, control and drainage, such as in the cited Colombian and Caribbean examples.

For naive buyers, slopes represent a cheap opportunity to access to land and housing; however, they will later experience a landslide or witness a neighboring one. Plans have neglected this threat as zoning has validated risky urbanization. Institutional capacity is slow to adapt to actual settlements. However, internal promoters help internalize LRR. Unfortunately, projects such as the new expressway network promote rapid unsafe urbanization in ATACABA, regardless of indisputable

socio-economic benefits. Some policies favored access to cheap land in exchange for reducing safety, while the benefits were collected by pirate developers and occasionally by leveraged politicians. The technical definition of LR is flexible and can benefit and harm simultaneously. Such is the case in defining the upper and lower borders of slopes to determine setbacks; likewise, for mitigation, whose access is, in practice, a determinant factor leading to the exclusion of the poor to landslide-poor areas.

The systemic nature of the problem makes it simultaneously dynamic and changing over time. Adaptation to conditions is a rule of survival for the marginalized but at the same time the *modus operandi* of pirate developers, with the complicity of utilitarian networks within public institutions, and politicians. An informal networks picture, promoting LRR and antagonist with a utilitarian vision, is shown in **Figure 6**. Therefore, LRR must also change and be monitored to be sustainable. Political periods pass, and while some benefit from the dilation, others have to start over with the solution. Former settlers pass, and newcomers build new realities on old, troubled land. Generational changes face the challenge to different understandings of the problem to resolve—hopefully in due course, in light of improper urbanization encountering uncertain climate. The root causes of LR are not always—and not only—skewed development; rather, LR is a problem of misunderstanding one's coexistence with others and nature.

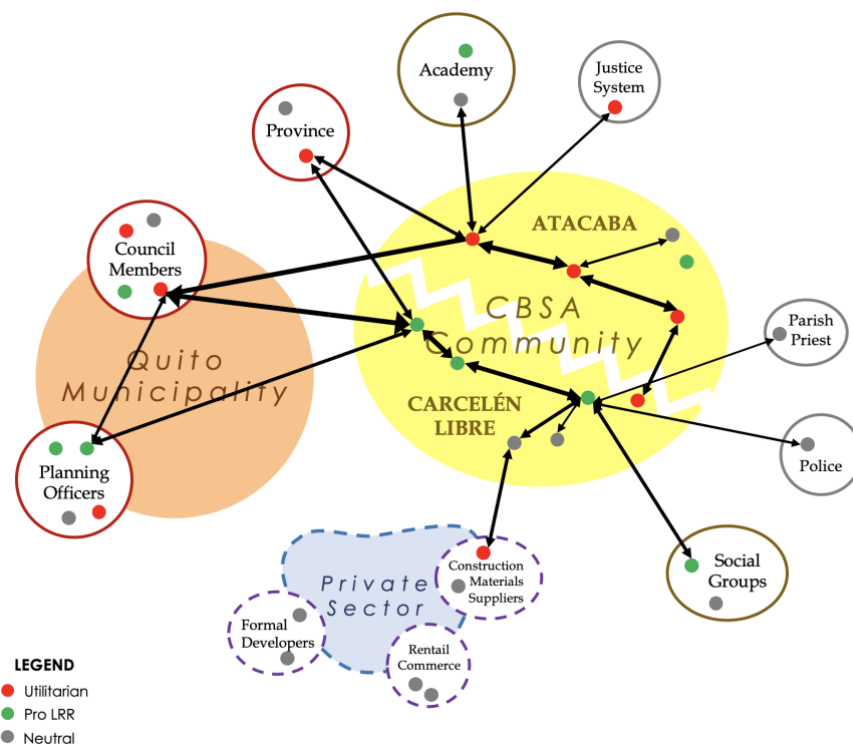


Figure 6. Informal networks through group actors in the production/reduction of LR in CBSA.

5. Conclusions

This article aimed to relate landslide risk reduction to current urban policies in the Andes, framed in different dimensions with inextricable links between them. Each dimension contributes in different ways and magnitudes to the components of landslide risk and vary in practice in successful and failures. These conclusions synthesize the main ideas from this review, our conceptual proposal and the example case.

A constructivist approach to understanding landslide reduction planning in the Andes is proposed. Generalizations of group actors, in this regard, may result in an inaccurate picture. Human dimensions are critical alongside a naturalistic view that often prioritizes analyses of the physical environment. This view, beyond its utility and historical contributions, needs to be challenged when implementing reductive measures.

The Andes are experiencing an increasing number of urban landslides that, compared to other regions, demand more thorough attention from scientific and professional communities but differently to previous efforts, matching bottom-up constructivist views with top-down policy and rationalistic approaches. Beyond some generalizations for the Andes, LRR policy design and implementation need specific local adaptations. Political cycles, institutional gaps, informal networks and informal land markets are not always visible but are often crucial and beyond the cliché policies. Furthermore, an often-neglected factor is the uncertainty of a changing climate, for which, the adaptation capacity of most settlements is not sufficient.

In complement, new methods of social organization are needed, including effective civic training, multi-age leading teams, the promotion of women, the creative use of social media, innovative awareness education, articulation with a pragmatic—though, groundbreaking—academia, the social responsibility of traditional media, which has largely been absent but may highly influence society towards solutions, and the private sector by offering socially-sensitive insurance plans and involvement in sustainable habitat projects.

In addressing risk-sensitive land-use policy, it is of vital importance to understand the systemic nature of LR production (see **Figure 1**). This combines policy-institutional, socio-cultural, socio-economic and environmental dimensions for the design of a landslide risk-reductive policy, leading to stronger potentials than the short-

term physical planning norms in Andean cities. Moreover, the sometimes-awkward interactions between these dimensions produce diverse nuances of LR production, requiring particular policy design.

The *ethos* of informal settlers regarding landslide reductive policies is adaptative, as illustrated above, to normative and socio-economic conditions. Residents could either obey the law, if they are able to do so, or they could infringe it in a discrete but creative way in collusion with other actors to obtain mutual benefit. Community and government behaviors regarding LR regulation often fall into patronizing and top-down exercises. Communities in LAC passively hope that someone will assist them. As successful examples show—mainly Colombian—LRR is potentially a root solution for many urban problems in the Andes.

More deeply investigating the causes of the production of LR would involve forensic studies of risk, exploring the influence of skewed development and global economic forces. Nonetheless, there are perceptible ways in which land policies could help reduce landslide risks, and good practices show that is possible to tackle the problem of landslide disasters. Finally, informality in the Andes, is a reality, whose management has the potential to be part of risk-reductive LUP, together with the understanding of the environment and an uncertain climate.

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ANNEX - LIST OF ACRONYMS

ATACABA	Asociación de Trabajadores Autónomos de Carcelén Bajo (Carcelén Bajo Autonomous Workers Association - neighborhood / subdivision)
CBSA	Carcelén Bajo Study Area (Includes Carcelén Libre, Atacaba and slopes to the ravine bottoms)
CC	Climate Change
CCA	Climate Change Adaptation
CL	Carcelén Libre neighborhood / subdivision
DR	Disaster Risk
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
FAR	Floor Area Ratio
LAC	Latin America and the Caribbean
LRR	Landslide Disaster Risk Reduction
LM	Land Management
LP	Land Policies
LR	Landslide Risk
LUP	Land Use Planning
LUPM	Land Use Planning and Management
LS	Landslide Susceptibility
MDMQ	Municipio del Distrito Metropolitano de Quito (Metroplitan District of Quito Government)
RP	Risk Perception
RS-LUP	Risk Sensitive Land Use Planning
TDR	Transfer of Development Rights
UN	United Nations
UNISDR	United Nations International Strategy for Disaster Risk, now called UNDRR, the United Nations Office for Disaster Risk Reduction
WB	World Bank