Mitigating Landslides in Bogotá's Periphery

Sustainable Social Housing Solutions

Daniela Diaz Avila (5901553)

Architectural Engineering Studio
Yannick Warmerdam
Mo Smit

2024

TABLE OF CONTENTS

CHOICE OF THE STUDIO

I selected the Architectural Engineering Studio for its dedication to innovation, and combination of technology with a commitment to creating impactful architectural solutions that address pressing environmental and societal issues. What distinguishes AE Studio, in my view, is its unique blend of autonomy and guidance, striking an ideal balance between freedom and structure, providing ample room for exploration within a supportive framework. I can pursue my research endeavors while learning from the expertise of experienced tutors. I also think it is interesting how we are encouraged to approach the problem in different ways, in my case learning from vernacular architectural engineering practices and exploring how these case studies can be adapted and implemented with today's technology.

KEYWORDS

1. **Climate Responsive** architecture refers to the ability of the building to adapt and reflect the site's weather conditions: factors such as sun intensity, harsh winds, rainfall, and humidity. Furthermore, it is also concerned with inhabitant well-being.

2. **Co-existence with nature** consists of the building causing the least environmental disruption and positively contributing to its context and surroundings.

3. **Local Materials** easily accessible resources in the area, which require shorter transportation times: contributing less to CO2.

4. **Social Housing** refers to governmental-owned housing for the benefit of those marginalized communities that cannot afford housing on their own.

5. **Passive Homes Housing** typologies that reduce the building's ecological footprint include thermal control, cross ventilation, radiation, shading and daylighting, and moisture control.

6. **Accessible for non-skilled labour** comprises low-difficulty construction techniques that do not require expertise.

7. **Comuna** refers to marginalized neighbourhoods in Colombia that suffer from difficult socioeconomic situations.

PROBLEM STATEMENT

From the turn of the 20th century to 2018, Colombia has experienced a staggering 30,730 documented landslides, resulting in the tragic loss of 34,198 lives[1], and devastating entire communities, including homes, schools, and recreational facilities. The persistent threat of landslides looms large over both urban and rural areas of Colombia, posing significant risks to community safety and stability. These natural disasters, often triggered by heavy rainfall, steep terrain, and extensive deforestation, highlight the profound vulnerability of communities across the nation.

According to a landslide susceptibility map from the Global Facility for Disaster Resolution and Recovery (GFDRR), twenty-five out of Colombia's thirty-two departments are classified as, high-risk/red zone[2] encompassing approximately 78% of the country's territory.

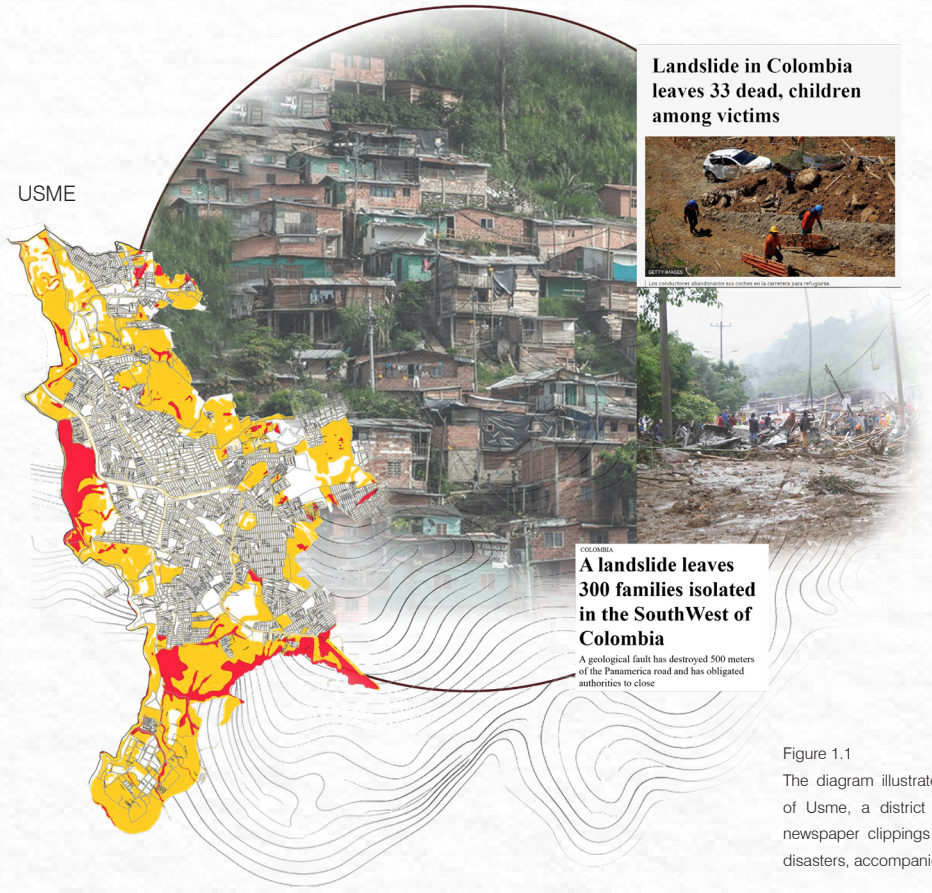


Figure 1.1
The diagram illustrates the landslide susceptibility map of Usme, a district in Bogota. Additionally, there are newspaper clippings showcasing the impacts of these disasters, accompanied by an image of a neighborhood.

Forced displacement further exacerbates Colombia's challenges, with victims often fleeing from armed conflict, either due to direct attacks or as a preventive measure against violent incidents. Non-state armed groups, such as guerrillas and paramilitaries, are primarily responsible for this forced migration, contributing to the exodus of thousands of Colombians. As a result, Colombia is home to a significant internally displaced population, estimated at 6.8 million as of the conclusion of 2022[3], representing As a result of being displaced, individuals resort to constructing their

1 Gómez, Derly & García, Edwin & Aristizábal, Edier. Spatial and temporal patterns of fatal landslides in Colombia. 2021
2 GFDRR. Think Hazard. Colombia 2020
3 Colombia Situation. The United Nations High Commissioner for Refugees (UNHCR). 2024

dwellings and settling wherever possible, primarily driven by necessity representing approximately 13% of the country's total population. This places Colombia among the nations grappling with the highest rates of displacement, both nationally and globally.

As a result of being displaced, individuals resort to constructing their dwellings and settling wherever possible, primarily driven by necessity. According to Martin-Molano more than 50 percent of Bogota has grown from informal settlements (2000, p. 66). However, socioeconomic limitations not only hinder the displaced population from accessing adequate infrastructure and materials but also have detrimental effects. Lacking technical expertise, they excavate without any technical knowledge, resulting in structures with little to no structural integrity, utilizing materials scavenged from the streets such as plastic, sticks, leftover wood planks, highly toxic asphalt screens, and Zinc tiles. Moreover, these inadequate excavation practices facilitate water flow through the mountain system from above, leading to ground fissures that increase the risk of landslides.

"We're still to some extent sleepwalking our way into disasters for the future which we know are going to happen, and not enough is being done to mitigate the damage."

—John Holmes, UN Under-Secretary-General for Humanitarian Affairs (Lynn 2009)

Figure 1.2 - Image credit: Andrés Felipe Rivera Ladino

Figure 1.3 - Image credit courtesy of Breaking Borders Tour

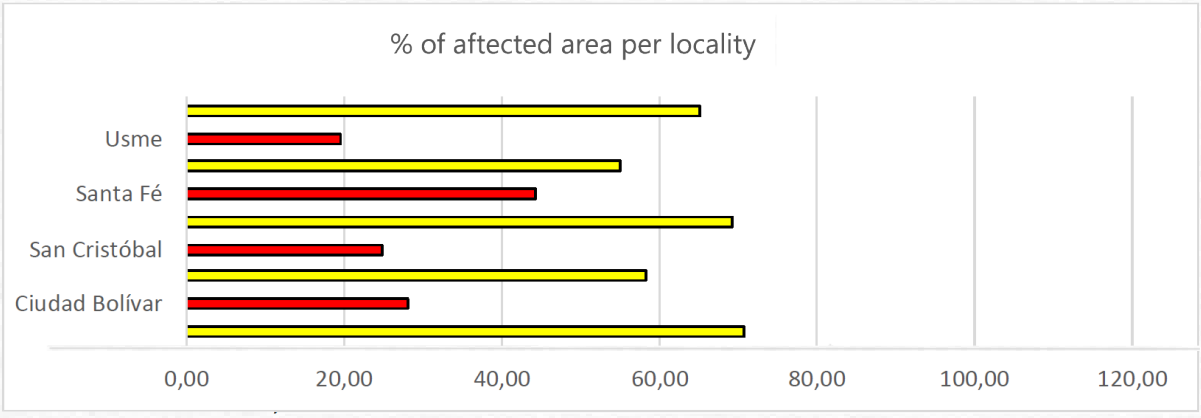


Figure 1.4
Comparative Areas subject to development affected by locality by medium and high threat due to mass movements (landslide). Graphic by Technical Support Document of The Bogotá Territorial Management Plan. Pg 20.

DESIGN OBJECTIVE

The overall design objective of the graduation project is to *revitalize a block within the San Cristobal slum, via the introduction of housing typologies and a communal space.* San Cristobal is situated in the mountainous periphery of Bogotá, where the constant threat of landslides poses a challenge. Through this project, I intend to *showcase a set of passive housing designs featuring diverse spatial characteristics* tailored to accommodate families of different sizes and needs, alongside communal or shared spaces. Moreover, these designs will be *informed by vernacular architectural engineering techniques*, prioritizing *structural stability, sustainability, and constructability*, including the utilization of *biobased and upcycled materials*. Presenting a vision for the community, I aim to demonstrate how their neighborhood can evolve sustainably while meeting their diverse needs.

This entails addressing the immediate need for safe housing and harmonizing with the local environment and cultural context. Recognizing and addressing the community's needs is a fundamental aspect of the research. Incorporating a social/communal space into the design is particularly intriguing, as a key strategy of the Bogotá Humana Development Plan[1], focuses on improving recreational spaces as part of crime prevention and urban security, emphasizing inclusivity by addressing diverse social groups needs, particularly in vulnerable areas resulting in lower crime rates in parks and the surrounding neighborhoods.

Moreover, I aim to design climate-responsive housing that ensures residents enjoy comfortable living conditions regardless of extreme temperatures. Alongside structural stability, the focus is on incorporating passive systems to enhance sustainability and resilience. These include elements such as rainwater harvesting systems, effective sun protection mechanisms, and natural ventilation strategies, all aimed at optimizing the environmental performance of the housing units while fostering a healthier and more livable environment for the occupants.

Overall Design Question

How can resilient, passive, and culturally sensitive housing, informed by vernacular practices, be designed with today's technology for a vulnerable community in Bogota's mountainous periphery, prone to landslides?

Subquestions:

» How can comfort in extreme climates with passive systems like rainwater harvesting and natural ventilation be ensured? Offering not just housing, but a holistic vision for sustainable community development.

» What criteria should be considered in selecting intervention locations, and how do these factors contribute to effective mitigation strategies for landslide-prone areas?

4 Secretaría Distrital de Planeación., Plan de desarrollo 2012-2016: Bogotá Humana 1–489 (2012). Bogotá; Alcaldía Mayor.

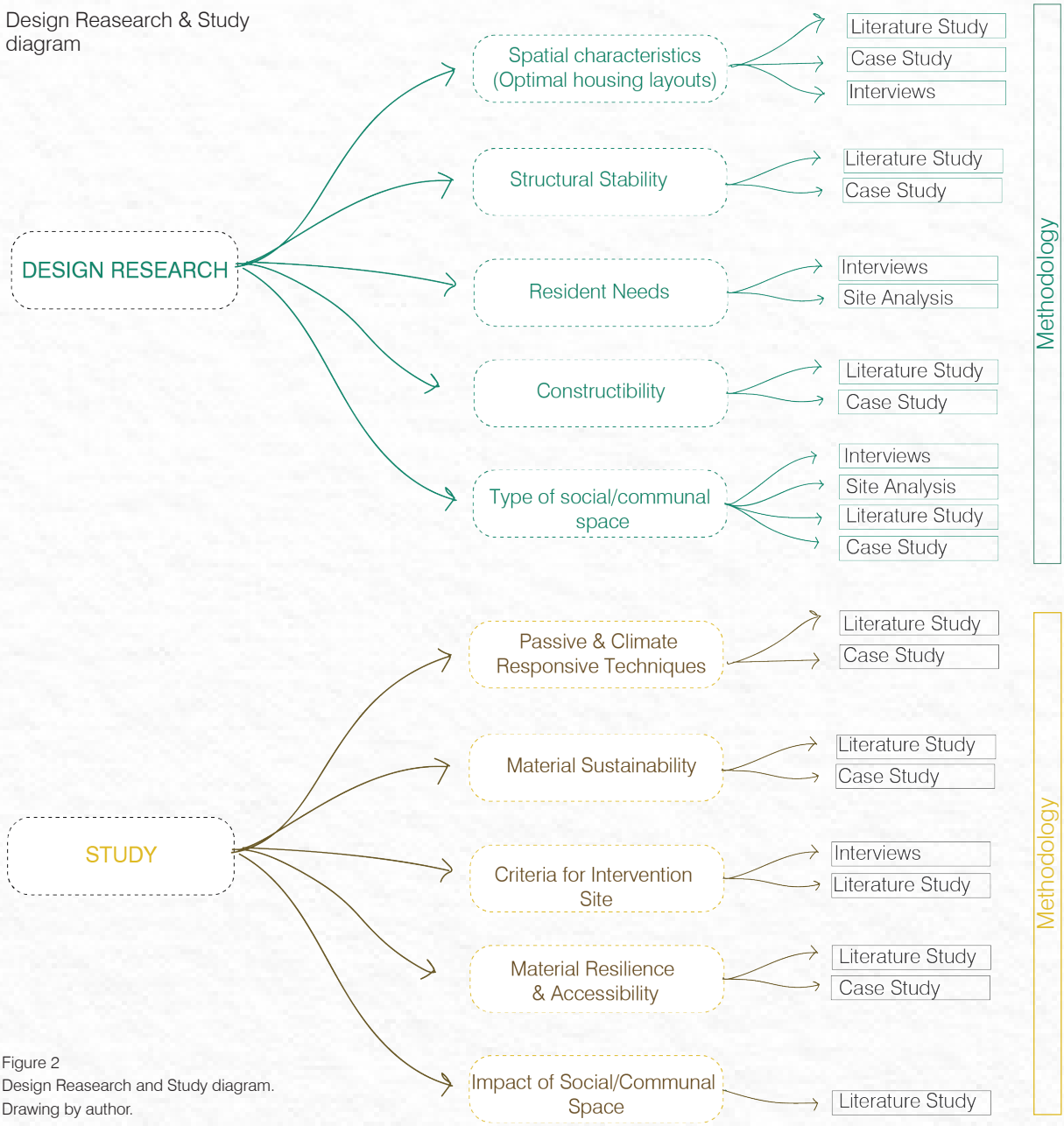


Figure 2
Design Reasearch and Study diagram.
Drawing by author.

Relevance

According to the technical document of support to the Territorial Order Plan of Bogotá, there are eleven localities located on the periphery of Bogotá that are at moderate to high risk of landslides. While the project's focus lies on the San Cristobal locality, the localities of Usme and Ciudad Bolivar are homogenous slopes, sharing similar geological layers, geomorphology, and relief, resulting in homogenous slopes. Both Usme and Ciudad Bolivar face the highest landslide risks coupled with the highest index of poverty and habitant density, and potential for urban expansion.

Therefore, by revitalizing a block within San Cristobal, architectural techniques and solutions can be extrapolated to address similar challenges encountered in other localities. This approach holds potential for application in regions facing analogous circumstances. Additionally, the design concepts and strategies developed could also offer valuable insights and benefits for other countries grappling with similar issues.

THEMATIC RESEARCH OBJECTIVE

The main thematic research objective is to establish guidelines that identify resilient vernacular construction techniques utilized in steep/mountainous terrains prone to landslides and earthquakes. Aiming to adapt these traditional methods with modern technology and locally sourced biobased and upcycled materials. The overarching goal is to address both the housing shortage and the vulnerability to landslides in peripheral areas.

Within a structured framework, the project will delve into the analysis of three to four distinct vernacular case studies in different regions of the world. These case studies should share commonalities such as comparable topography and altitude, and the utilization of local and biobased materials, yet they each face unique cultural needs, climatic conditions, and challenges. By examining these diverse contexts, the goal is to gain comprehensive insights into the adaptability and efficacy of vernacular architectural strategies across varying environmental parameters.

The research then explores the application of existing technology and devises a methodology to introduce new construction techniques using locally available and upcycled resources. Empowering residents who are currently constructing their own dwellings by providing accessible building methods. Consequently, the strategy and design must be accessible for non-skilled labour.

Furthermore, the intervention location was chosen based on a framework that consisted of factors such as the percentage of susceptible landslide area by locality (mid-high risk), zones identified as first and second priority, delimitation of homogenous slopes, index of population density and poverty, space and plan for expansion and finally site accessibility (for visiting and interviewing the residents).

.

Thematic Research Question

How can vernacular architecture and construction techniques used in steep/mountainous terrains susceptible to landslides and earthquakes be adapted with modern technology and locally sourced biobased and upcycled materials to address inadequate/housing shortages and landslide vulnerability in peripheral areas?

Subquestions:

» What are the key characteristics of resilient vernacular construction techniques in steep/mountainous terrains prone to natural disasters?

» How can these vernacular techniques be reinterpreted and adapted to today?

» How can ensuring that these techniques are designed for ease of construction by unskilled labour and are readily replicable be achieved?

Thematic Reseach diagram

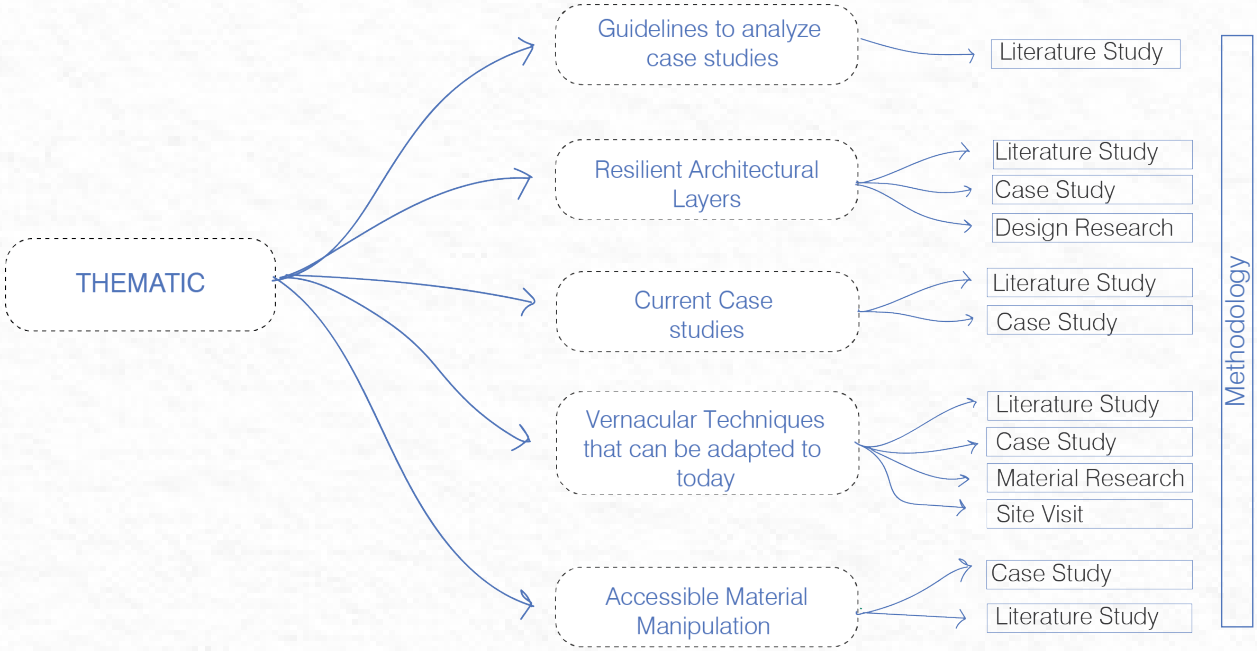


Figure 3
Thematic research diagram.
Drawing by author.

Relevance

The thematic research holds significance due to the loss of effective vernacular architecture methods over time, leading to construction practices that often disregard environmental factors and climate responsiveness. Moreover, adapting these vernacular techniques can make the building process more accessible for non-skilled laborers. Furthermore, traditional methods and structures have showcased remarkable resilience, enduring natural calamities like landslides and earthquakes- standing the test of time.

The project seeks to support communities residing in the mountainous outskirts of Bogota who are facing significant challenges. Socioeconomic factors impact the accessibility of materials for their homes, prompting my design to explore the use of upcycled materials, such as tires known for their anti-seismic properties, and resilient biobased materials like bamboo. This approach aims to address both structural needs and economic constraints while promoting growth and sustainability in construction practices.

METHODOLOGY

The chosen methods are mixed- both qualitative and quantitative

Investigation:

My methodology begins with investigation and data collection on vernacular architectural practices in mountainous regions faced with landslide and earthquake challenges, primarily via case studies through literature. Subsequently, I will construct a guideline to systematically analyze and contrast various case studies, considering factors such as altitude, morphology, climate patterns, and materials utilized. Furthermore key architectural layers will also be analyzed such as foundations, walls, landscape interventions and roofs.This analysis aims to discern landslide resilient approaches and identify shortcomings. Concurrently, I will investigate current case studies addressing landslide challenges in different countries, seeking commonalities in the methods and materials employed.

With the selection of San Cristobal as the intervention site, comprehensive research is necessary to identify locally available biobased and upcycled materials and assess their accessibility. Additionally, smaller studies that will inform the design process will be conducted, such as the potential passive design strategies both from findings of vernacular and modern case studies.

The next step involves pinpointing two potential site locations through an examination of the locality's development plans, expansion areas, protected zones, projected neighborhood growth, and susceptibility to landslides. Furthermore, a detailed site analysis will be conducted, considering factors such as climate patterns, solar orientation, historical context, and the demographic and socioeconomic characteristics of the residents.

Research Trip:

During the research trip, I will visit the site to document and evaluate its existing conditions, (housing structures and layouts, vegetation, road networks, family demographics, and prevalent building materials). Additionally, I will also interview the residents to gather insights into their perceptions of landslide risks, including any undocumented occurrences, and cross-reference this information with the technical documentation from the 2019 Plan of Territorial Order in Bogota. Furthermore, I will inquire about the community's spatial needs to inform future design decisions. Establishing communication with the Local Administrative Board (JAL) and the San Cristobal community Action team is crucial in order to understand their priorities and assess the feasibility of the proposed design.

As upcycled tires and bamboo are identified as ideal materials thus far, I plan to interview architects specializing in bamboo construction techniques, as well as environmentalist Alexandra Posada, who focuses on passive design strategies and building using tires. These interviews will provide valuable insights into the practicalities and challenges associated with working with these materials.

RESEARCH PLAN METHODOLOGY

Sub-Questions	Data Required	Collection Methodology	Analysis Method	Expected Outcome
How can comfort in extreme climates with passive systems like rainwater harvesting and natural ventilation be ensured? Offering not just housing, but a holistic vision for sustainable community development.	◦ Climatic data & Environmental factors ◦ Types of possible passive systems ◦ The effect these systems may have on building performance ◦ The current Environmental condition	◦ Literature Review ◦ Case Study ◦ Interviews ◦ Site Visit	◦ Comparative statistical analysis ◦ Data-Driven design for optimal building orientation, shading etc.	◦ Performance Advantages. ◦ Greater Comfort for occupants
What criteria should be considered in selecting intervention locations, and how do these factors contribute to effective mitigation strategies for landslide-prone areas?	◦ Geological, Topographic & Infrastructure ◦ Territorial Plan & Expansion possibility ◦ Demographic & Socio-economic data ◦ Community knowledge and experience	◦ Literature Review ◦ Site Analysis ◦ Interviews (Community participation) ◦ Stakeholder Engagement	◦ Comparative Overview.	◦ Site Selection
What are the key characteristics of resilient vernacular construction techniques in steep/mountainous terrains prone to natural disasters?	◦ Building Performance/ Resilience against landslides ◦ Techniques used in the different architectural layers ◦ Geological, Topographical & Climate Data	◦ Literature Review ◦ Case Study	◦ Quantative and qualitative analysis ◦ Comparative overview.	◦ A list of vernacular techniques resilient to landslides.
How can these vernacular techniques be reinterpreted and adapted to today?	◦ Documentation of traditional techniques ◦ The local environment conditions ◦ Materials used ◦ Environmental Impact	◦ Literature Review ◦ Case Study ◦ Archival Research	◦ Comparative Overview with current case studies and methods.	◦ Insight into the types of technology that can be used and are accessible..
How can ensuring that these techniques are designed for ease of construction by unskilled labour and are readily replicable be achieved?	◦ The techniques from question 4. ◦ Analysis of construction process. ◦ Assessment of skill levels ◦ Data on homogenous mountains (Replicability of typologies)	◦ Literature Review ◦ Case Study ◦ Community feedback	◦ Quantative and qualitative analysis ◦ Comparative overview.	◦ Identify the best materials and construction process so that the community can participate and replicate.

EXPECTED RESULTS OF THEMATIC RESEARCH AND DESIGN IMPLEMENTATION

From the thematic research and vernacular architecture case studies conducted via literature study, I intend to identify overarching construction component and materials that were resilient against landslides. I will then contrast and compare these methods with modern day case studies and current site conditions. The aim is that the result obtained from this study will inform the design, construction techniques and materials chosen that will be suitable for housing construction, while optimizing environmental suitability.

Moreover, throughout the design phase, I will develop the research findings into potential architectural solutions through typologies (about 3 housing typologies) that address the needs of the San Cristobal community, enhance their living standards and can also be implemented in homogenous slopes and similar localities like that of Ciudad Bolivar and Usme. This approach ensures that the proposed housing design not only addresses practical needs but also incorporates the recreational space strategy from the Bogotá Humana Development Plan (2012-2016), fostering community engagement and opportunity for growth.

Expected Results Diagram

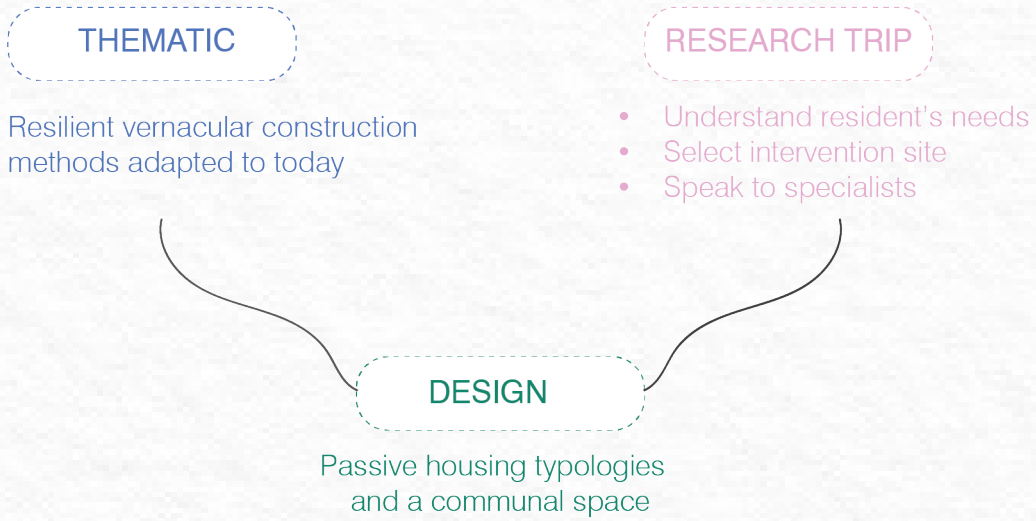


Figure 5
Expected output from each stage. Drawing by author.

RESEARCH SCHEDULE

	Msc 3																
Month	March			April				May				June					July
Week	3.5	3.6	3.7	3.8	3.9	3.10	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	5.10
Dates	03/11/2024 - 03/15/2024	03/18/2024 - 03/22/2024	03/25/2024 - 03/29/2024	04/01/2024- 04/05/2024	04/08/2024 - 04/12/2024	04/15/2024 - 04/19/2024	04/22/2024 - 04/26/2024	04/29/2024 - 05/03/2024	05/06/2024 - 05/10/2024	05/13/2024 - 05/17/2024	05/20/2024 - 05/24/2024	05/27/2024 - 06/31/2024	06/03/2024 - 06/07/2024	06/10/2024 - 06/14/2024	06/17/2024 - 06/21/2024	06/24/2024 - 06/28/2024	07/01/2024 - 07/05/2024
Milestones					**P1** Final Research Plan Proposal									**P2** Research Results & Preliminary Design Concept			
Task	Develop Research Plan					Investigation						Conclusions			Research Trip		
Thematic	Thematic Research Question and subquestions				Develop Guidelines to analyze vernacular techniques		Vernacular Case Study & Current Case study 1			Vernacular Case Study 3 & Current Case study 3							
			Design Research proposal plan. Evaluate information and revise paper. Prepare presentation.					Vernacular Case Study 2 & Current Case study 2				information and develop charts and diagrams					
													Finalize and revise paper				
Design	Overall Design Question					Collect Site Data and contrast with case studies		Materiality		Identify needed spatial characteristics							
Study		Criteria for site intervention					Possible Passive techniques							Material resilience and accessibility			

	Msc 4																
Month	September			October				November				December					Holiday
Week	1.1	1.2	1.3	1.4	1.5	1.60	1.7	1.8	1.9	1.10	2.1	2.2	2.3	2.4	2.5	2.6	
Dates	09/03/2024- 09/06/2024	09/09/2024 - 09/13/2024	09/16/2024 - 09/20/2024	09/23/2024 - 09/27/2024	10/01/2024 - 10/04/2024	10/07/2024 - 10/11/2024	10/14/2024 - 10/18/2024	10/21/2024 - 10/25/2024	10/28/2024 - 11/01/2024	11/04/2024 - 11/08/2024	11/11/2024 - 11/15/1014	11/18/2024 - 11/22/2024	11/25/2024 - 11/29/2024	12/02/2024 - 12/06/2024	12/09/2024 - 12/13/2024	12/16/2024 - 12/20/2024	12/23/2024 - 01/03/2025
Milestones					**P3** Progress Review										**P4** Formal assessment Go/No Go		
Task	Schematic Design						Drawing sets								Continue Working		
Thematic				Materiality implementation	Structural concept and technical details										Presentation		
Design	Site analysis & Climatic conditions		defenition & needs of people				Typology 1- schematic drawing set	Typology 2- schematic drawing set		Typology 3- schematic drawing set		Communal space- schematic drawing set				Refine drawings	
Study			Material a														

	Msc 4		
Month	January		
Week	2.7	2.8	2.9
Dates	01/06/2025 - 01/10/2025	01/13/2025 - 01/17/2025	01/20/2025 - 01/24/2025
Milestones			**P5** Final Presentation
Task			
Thematic		Prepare presentation	
Design	Final vizualization		
Study			

BIBLIOGRAPHY

Literature:

Amico, C. J. (2017). Ciudad y Territorio en los Andes: Contribuciones a la historia del urbanismo prehispánico (2nd ed.). Fondo Editorial de la Pontificia Universidad Católica del Perú.

Anderson, Malcolm G., and Elizabeth Holcombe. Community-Based Landslide Risk Reduction: Managing Disasters in Small Steps, World Bank Publications, 2013.

Bamboo Diversity and Traditional Uses in Yunnan, China Yang Yuming, Wang Kanglin, Pei Shengji, Hao Jiming. Mountain Research and Development Vol. 24, Issue 2, (May 2004) , pgs 157-165

Barón Zambrano, J.R.,& Sánchez Peña, L. (2014). Viabilidad de Muros de Llantas Para la Estabilización de Taludes en el Barrio La Capilla- Soacha Cundinamarca.

Castillo-Palacio, M., Harrill, R., & Zuñiga-Collazos, A. (2017). Back from the brink: Social transformation and developing tourism in post-conflict medellin, colombia. Worldwide Hospitality and Tourism Themes, 9(3), 300-315. doi:https://doi.org/10.1108/WHATT-02-2017-0012

Earthships Going Strong: Scrap Tire Homes Keep Rolling Along. (1995, November). BioCycle.

Garcia-Delgado, H., Petley, D. N., Bermúdez, M. A., & Sepúlveda, S. A. (2022). Fatal landslides in Colombia (from historical times to 2020) and their socio-economic impacts. Landslides, 19(7), 1689–1716. https://doi.org/10.1007/s10346-022-01870-2

Hernández-García, Jaime. (2013). Slum Tourism, City Branding and Social Urbanism: The Case of Medellin, Colombia. Journal of Place Management and Development. 6. 10.1108/17538331311306122.

Herrera-Coy MC, Calderón LP, Herrera-Pérez IL, Bravo-López PE, Conoscenti C, Delgado J, Sánchez-Gómez M, Fernández T. Landslide Susceptibility Analysis on the Vicinity of Bogotá-Villavicencio Road (Eastern Cordillera of the Colombian Andes). Remote Sensing. 2023; 15(15):3870. https://doi.org/10.3390/rs15153870

Pope, K. (2015). RECYCLING to the Max. Planning, 81(3), 42-46. https://www.proquest.com/trade-journals/recycling-max/docview/1667966886/se-2

Rapoport, A. (1969). House form and culture. Englewood Cliffs, N.J., Prentice-Hall.

Translated by ContentEngine, L. L. C. (2019, Dec 18). A Sustainable School: The story of a public school to be built on recycled materials. CE Noticias Financieras https://www.proquest.com/wire-feeds/sustainable-school-story-public-be-built-on/docview/2328588317/se-2

Sotomayor, L. F. (2015). Planning through Spaces of Exception: Socio-Spatial Inequality, Violence and the Emergence of Social Urbanism in Medellín (2004-2011), [Doctoral dissertation, University of Toronto].

Government Reports:

Córdoba Alvarado, A.et all , Proceso de Revision del Plan de Ordenamiento Territorial de Bogotá D.C Documento de Diagnostico por Localidad No. 4 San Cristobal. 1–121 (2020). Bogotá, Cundimarca; Secretaria de Planeacion.

Secretaría Distrital de Planeación., Plan de desarrollo 2012-2016: Bogotá Humana 1–489 (2012). Bogotá; Alcaldía Mayor.

Vargas, R., Arévalo S., D., Bejarano, M. A., Peña Pinzón, C. F., Chaparro Fajardo, O. I., & Castillo, E., Libro 1. Contenidos Estratégicos Título 2. Estrategia de ordenamiento para el territorio distrital Plan de Ordenamiento Terrritorial de Bogotá. Anexo 15 del Documento Técnico 04. Áreas con Condición de Amenaza y Riesgo 1–169 (2019). Bogotá, Cundimarca; Instituto Distrital de Gestión de Riesgos y Cambio Climático IDIGER.

APPENDIX

Como producto del cruce mencionado, en las siguientes tablas y figuras se discriminan por Localidad los porcentajes de las áreas objeto de desarrollo, que se categorizan en amenaza Alta y Media, considerando los eventos amenazantes: Movimientos en Masa, Inundación por Desbordamiento y Avenidas Torrenciales. Las salidas cartográficas con los mapas por localidad se muestran en los numerales 2.3 a 2.16:

High and Mid Risk by landslides.

2.2.1 Amenaza alta y media por Movimientos en Masa

Tabla 2.1. Porcentajes del área objeto de desarrollo afectadas por amenaza media y alta por movimientos en masa.

Table 2.1 percent of areas subject to development affected by mid to high risk by landslides.

AMENAZA	LOCALIDAD	% ÁREA AFECTADA POR LOCALIDAD
Alta	Candelaria	0,06
Media		99,94
Alta	Chapinero	29,28
Media		70,69
Alta	Ciudad Bolívar	28,04
Media		58,26
Alta	Rafael Uribe Uribe	57,95
Media		38,45
Alta	San Cristóbal	24,81
Media		69,20
Alta	Santa Fé	44,23
Media		54,98
Alta	Suba	0,42
Media		7,44
Alta	Tunjuelito	2,32
Media		32,10
Alta	Usaquén	6,88
Media		24,31
Alta	Usme	19,52
Media		65,08
Alta	Sumapaz	0,00
Media		0,00

First locality at mid risk →

99.94% of the locality is at mid risk.

- 28% High risk
58% Mid risk

Second locality at High risk →

1 - Ciudad Bolivar
2 - San Cristobal
3 - Santa Fé
4 - Usme
5 - Candelaria.

→

1. Ciudad Bolivar
2. Usme
3. San Cristobal

2.6 ÁREAS CON CONDICIÓN DE AMENAZA PARA LA LOCALIDAD DE SAN CRISTÓBAL

2.6.1 Amenaza alta y media por Movimientos en Masa

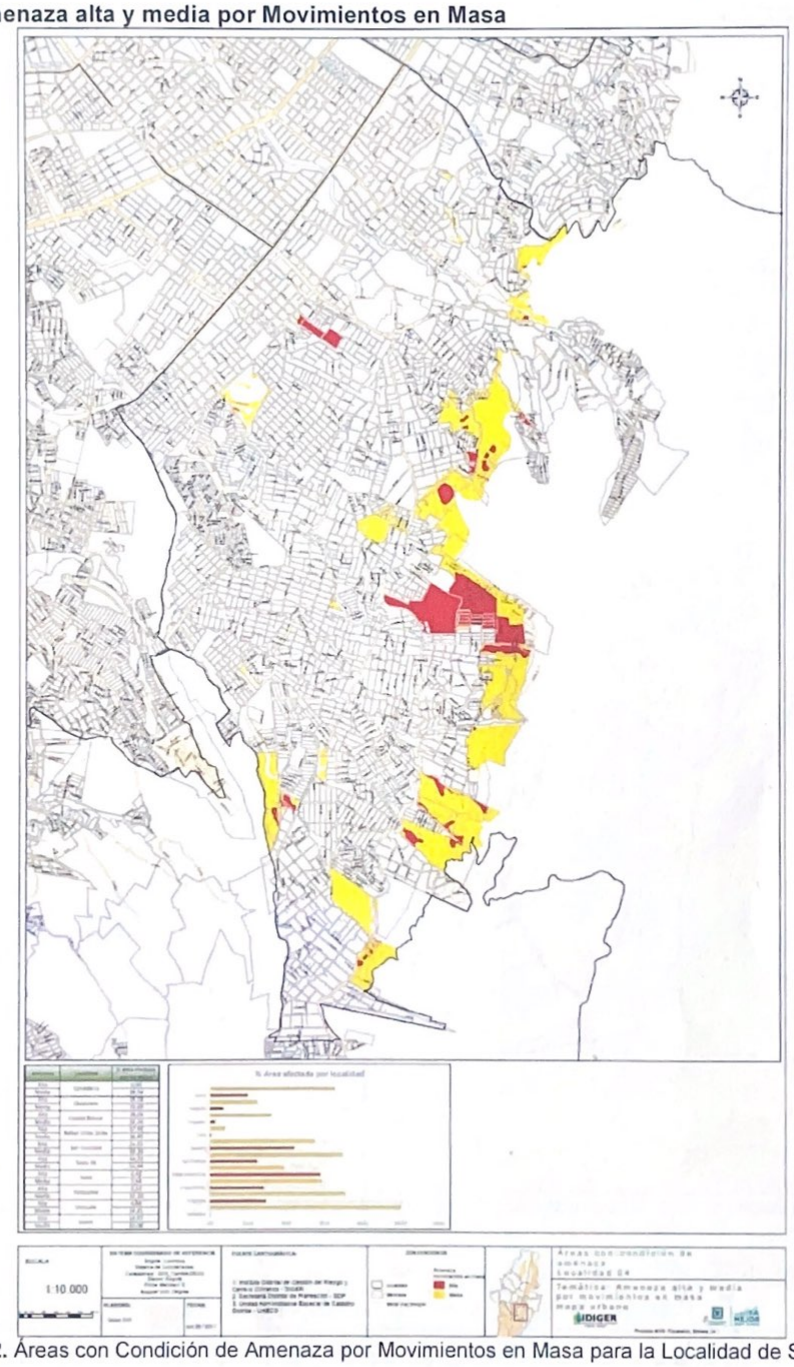
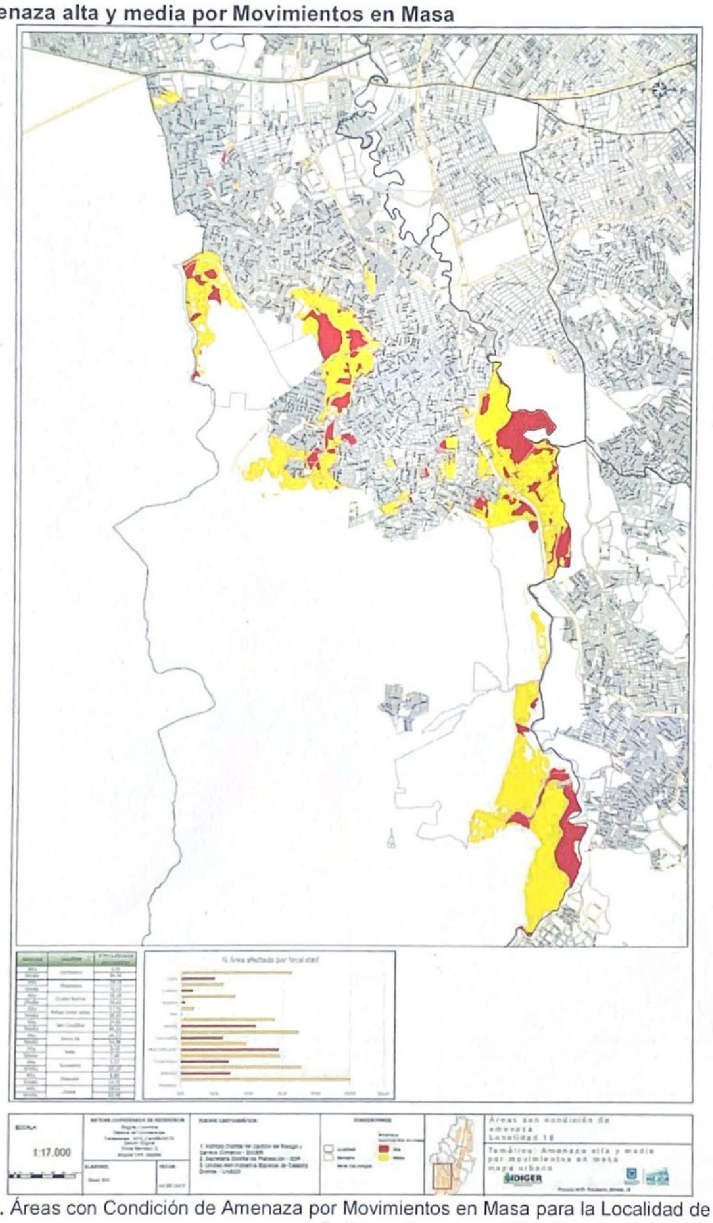


Figura 2.12. Áreas con Condición de Amenaza por Movimientos en Masa para la Localidad de San Cristóbal

Ideal

2.16 ÁREAS CON CONDICIÓN DE AMENAZA PARA LA LOCALIDAD DE CIUDAD BOLÍVAR

2.16.1 Amenaza alta y media por Movimientos en Masa



- 360 barrios
- 12998.4 H
  - 3237.8 urban
  - 204.65 H expansion
  - 9555.9 rural
- 717279 pop.
- 0.64 equipamientos per 1000 hab.
- 64.32% estrato 1
  21.32% estrato 2.
  (more than 95%.)
- only has 5 sport/recreational spaces = 0.32 H

Figura 2.30. Áreas con Condición de Amenaza por Movimientos en Masa para la Localidad de La Ciudad Bolívar

* the low equipamiento is mostly due to a lack of planification in the development of a great urban area where the existence of informal / illegal settlements is very frequent.

- 7.6% of Administrative/institutional are at risk
- 10.3% of sanitary assistance is at risk
- 16% of educational/cultural spaces are at risk.

Ideal

2.7 ÁREAS CON CONDICIÓN DE AMENAZA PARA LA LOCALIDAD DE USME

2.7.1 Amenaza alta y media por Movimientos en Masa

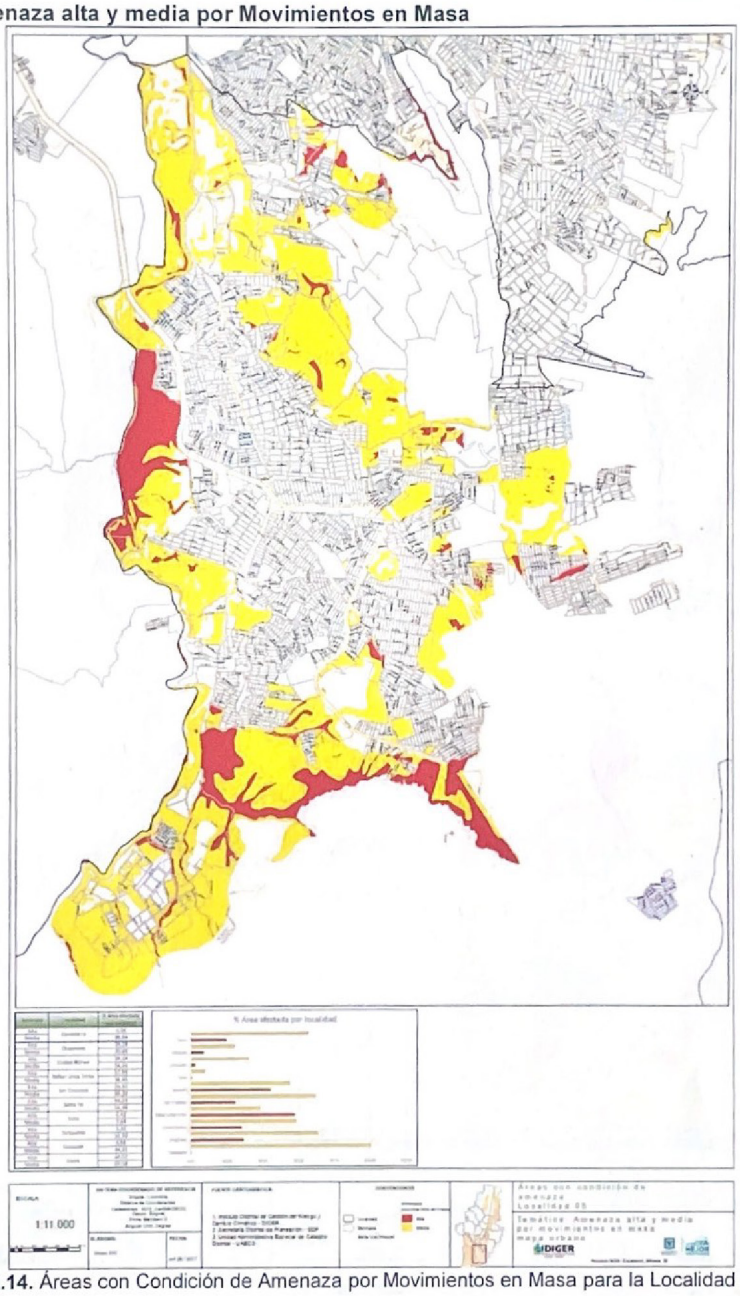
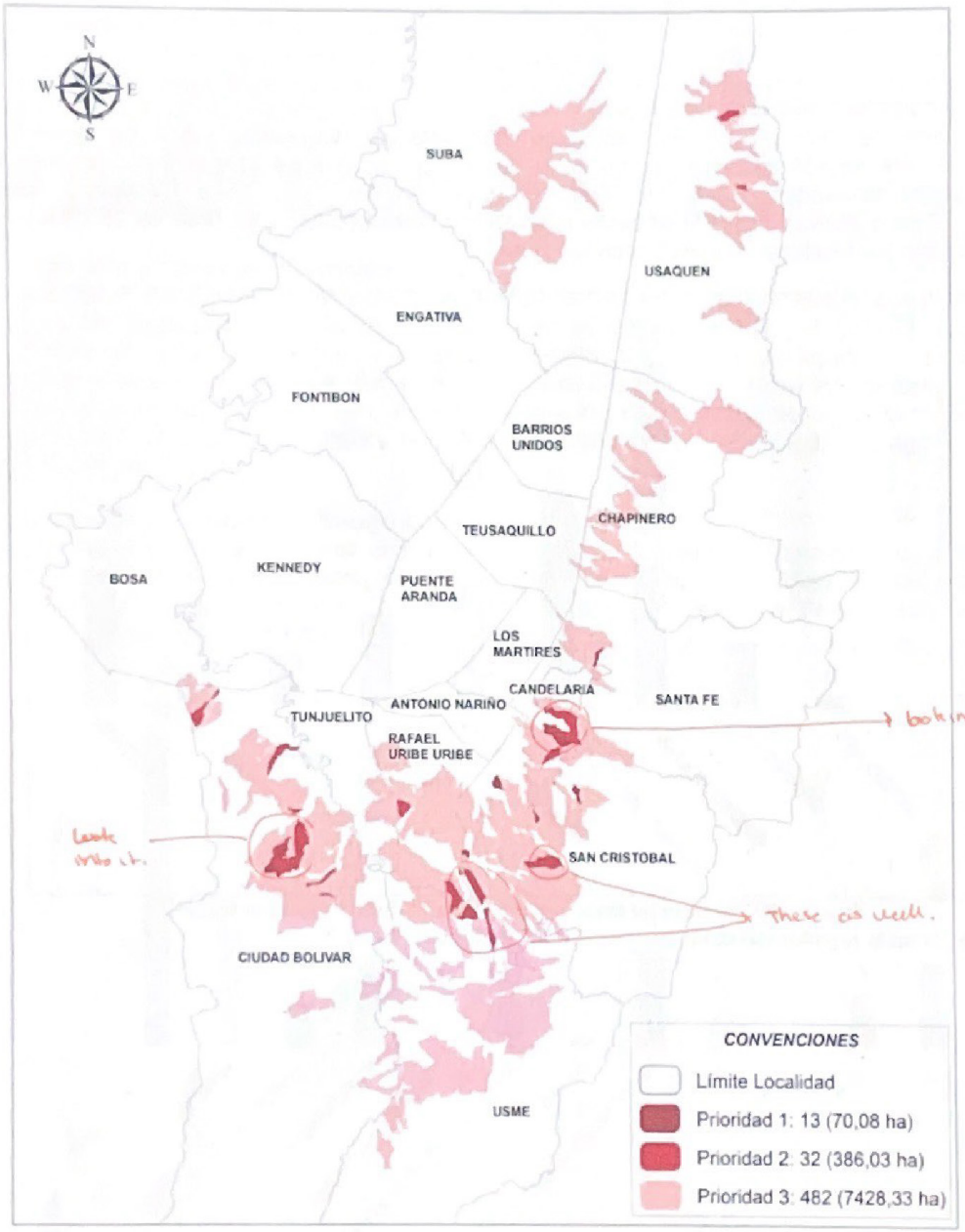


Figura 2.14. Áreas con Condición de Amenaza por Movimientos en Masa para la Localidad de Usme

21,556 H
- [illegible] H
  - ↳ 2063.84 urban floor
  - ↳ 1185.65 expansion floor
  - ↳ 18306.5 rural
- 334,862 inhabitants
- 52,7% estrato 1
- 30,7% estrato 2 (83,4% poverty)
- 0,38 h that have 'Educative cultural' at risk
- 0,51 H of construction may be affected by landslides.
- Has 3 recreational (sport spaces) = 0,62 H

- 4,7 %. of constructions are at risk
- 3 %. of Educational / cultural spaces are at risk.



IDIGER Instituto Distrital de Gestión de Riesgos y Cambio Climático

FIGURA
ZONAS CON CONDICIÓN DE RIESGO
BOGOTÁ

BOGOTÁ MEJOR PARA TODOS

Página 166 de 169