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Research Article

Disaster Risk Management Plans for Resilience in Populated Areas the Foothills of the Andes of Ecuador. Chimbo Canton Case

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ABSTRACT

By concentrating the population infrastructure, economic activities and livehoods, population areas, present greater exposure to the effects of disasters, for this reason, it is necessary to develop risk management plans that comprehensively guide disaster risk reduction in the territories. The study was developed in the parishes of the Chimbo canton, which is located in the foothills of the western mountain range of the Ecuadorian Andes, with the objective of "developing disaster risk management plans to strengthen capacities for community security and resilience". Methodologically, the research was based on a qualitative and participatory approach, information from official sources at the national and local level was systematized, the cartography was processed and elaborated using the ArcGis 10.3 software and complemented with fieldwork, the results were socialized and validated with territorial actors who contributed to adapting the plans to the local reality. The outcome was five risk management plans for the intervention parishes (San José, San Sebastián, Asunción, Magdalena and Telimbela), which contain the components of diagnosis, proposal and management model. As a conclusion, disaster risk management plans developed in a participatory manner are instruments for strengthening the capacities and resilience of populations at the local level and the methodology and experience can be replicated in other territories.

Keywords: Territorial actors, local plans, disaster risks and resilience.

INTRODUCTION

The International Disaster Database (EM-DAT) reports that in 2023 there were 399 natural disasters that produced 86,473 fatalities and 93.1 million people affected, even exceeding the 20-year average of 64,148 deaths; the events with the highest incidence in their order were: floods, earthquakes, droughts and extreme temperatures; the majority of deaths (73.4%) and affected (74.4%) were recorded in Asia, however, the greatest economic losses (43.9%) occurred in the Americas(1).

The impact of disasters is related to poorly managed risks, since they are not considered in the models and processes of local development and occupation of the territory, for this reason, they require the incorporation of planning, ordering and territorial development tools, which must have the participation and commitments of territorial actors, such as: local governments, public and private institutions, as well as the population(2).

Additionally, it should be considered that population centers are exposed to different disaster risks, however, the economically weakest families are the most vulnerable due to their geographical location (exposure to risks) and accessibility to resources, factors that influence resilience to disasters(3); therefore, social vulnerability and resilience are critical components for disaster risk management (4)For this reason, assessing vulnerability, resilience and their evolution over time is necessary to understand the dynamics and interaction, since high vulnerability affects the low resilience of the population to disaster risks and the impact of climate change(5).

Similarly, the increase in disaster risks is due to rapid urbanization and the effects of climate change, which requires better integration between disaster risk management and territorial planning processes to improve the resilience of cities and population centers, as well as contribute to sustainable development processes at different scales(6); In addition, it is necessary to strengthen individual and community resilience based on factors such as "knowledge", "willingness" and "action" to work on disaster risk reduction in the territories(7).

Territorial planning and ordering is a good corrective measure in the face of the accelerated and disorderly growth of population centers[8], which increases vulnerability and risk; similarly, territorial planning at the local scale, by including risk assessment, facilitates decision-making and the implementation of reduction measures[9]; Similarly, it should be emphasized the importance of integrating resilience into local plans as an important step to improve disaster risk reduction, thus contributing to the Sustainable Development Goals, specifically in Goal 11, target 11.b, which emphasizes increasing the number of cities and human settlements that adopt and implement policies and plans for disaster resilience[10].

To this end, in the planning processes and development model of the territories, it is necessary to incorporate the disaster risk management component, the United Nations – UN defines as "the application of disaster risk reduction policies and strategies with the purpose of preventing new disaster risks, reducing existing disaster risks and managing residual risk, thereby contributing to the strengthening of resilience and the reduction of disaster losses"[11], this implies working with a comprehensive approach that includes risk analysis and reduction, management of adverse events and recovery; for this, steps such as: delimiting and evaluating areas prone to events (e.g. floods), to draw up hazard or threat maps and to develop risk management plans[12].

In Ecuador, as well as in other emerging countries such as the city of eThekwini (South Africa), local governments and Disaster Management Units have limitations in their capacities, in addition, the reactive approach (disaster response) prevails instead of proactive, as evidenced by the lack of disaster risk management plans based on an assessment of the risks of the territories[13]. In the same sense, it should be mentioned that the risk management component in planning processes must apply a paradigm shift from exclusively disaster management practices, focused on response and recovery, to broader risk management initiatives focused on risk analysis, prevention, mitigation, preparation, response and recovery[14].

Ecuador's National Risk and Emergency Management Service (SNGRE) defines disaster risk management plans as "the instrument that defines the objectives, programs, actions, persons responsible and budgets through which risk awareness, risk reduction and disaster management processes are executed"[15], therefore, it is necessary to develop and implement disaster risk management plans that contribute to the resilience and sustainability of territories, mainly at the local scale.

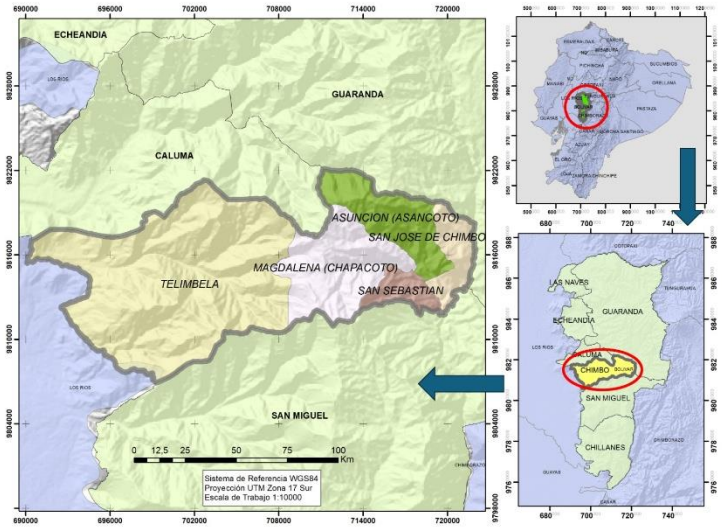
According to the document "National Plan for Risk Reduction in Ecuador" prepared by the Secretariat of Risk Management – SGR in 2023, among the recurring threats that have generated great impacts in Ecuador are floods, water deficit and droughts, mass movements, earthquakes, tsunamis, volcanic hazards and forest fires; events that have affected local and national development processes[16].

The territory of the Chimbo canton, located in the foothills of the Andes of Ecuador, is exposed to earthquakes, landslides, fires, among other threats that put the population, infrastructures and livelihoods at risk[17]; for this reason, in coordination between the State University of Bolívar (UEB) through the second cohort of the Master's Degree in Risk Prevention and Management and the Decentralized Autonomous Government (GAD) of the Canton of Chimbo, the second phase of the linkage project called "Strengthening capacities for security and resilience in the urban areas of the Chimbo canton" was executed, with code 27-VS-I-2022"; aimed to design the methodology and develop disaster risk management plans for the strengthening of capacities for security and resilience in the five parishes: San José, La Asunción, La Magdalena, San Sebastián and Telimbela of the Chimbo canton; The result was five risk management plans with the participation of territorial actors, which constitute instruments for decision-making, resource management and implementation of disaster risk reduction actions in populations at the local scale.

MATERIALS AND METHODS

The study was carried out in the canton of Chimbo, belonging to the province of Bolívar, is located in the foothills of the Western Cordillera of the Ecuadorian Andes, presents an irregular topography with an altitude from 3,300 meters above sea level (highlands) to 1,000 meters above sea level (subtropics) and varied climate, with a territorial extension of 26,984.7 hectares (ha) that represent 6.8% (395,692.6 ha) of the territory of the province of Bolívar(GAD Chimbo, 2019)[18]; It has a total of 15,524 inhabitants [19] and it is made up of five parishes: San José, La Asunción, La Magdalena, San Sebastián and Telimbela (figure 1).

Figure 1. Location of the Chimbo canton (study area) on the provincial (Bolívar) and national (Ecuador) scales.



Source: (18) and (36)

The research was developed through a qualitative approach and with the participation of territorial actors, which according to (20) allows the collection of certain data that facilitate statistical analysis and thus achieve satisfactory results, these data are analyzed using statistical and mathematical tools to identify correlations and trends, since, from the characterization of the population, local threats and resources, the measures and management model for disaster risk reduction for the territories were developed.

The methodological model for the design of risk management plans for the five intervention parishes is composed of three components: diagnosis, proposal and management model.

In the diagnostic component, a characterization of the territory was carried out, identification of the main dangerous events and their impact, threats and available resources; for this, official information available from the National Institute of Statistics and Census – INEC (2022), Development and Territorial Planning Plans – PDOT at the cantonal and parish level, as well as a review of secondary information from specialized websites related to the subject of study were systematized.

Similarly, cartography from official sources was used, such as: for the hazardous events at a scale of 1:5,000 of the National Secretariat of Risk Management – SNGR (2024) and DESINVETAR (2024) complemented with fieldwork, for the threat of mass movements of the Secretariat of Risk Management – SGR (2011) scale 1:50,000, flood threat of the SGR (2015) scale 1:25,000, seismic hazard of the Ecuadorian Construction Standard – NEC (2015) scale 1:500,000, threat of frost and desertification of the GAD province of Bolívar (2019) at a scale of 1:25,000, threat of forest fires of the SGR (2019) at scale 1:50,000, for territorial limits of the National Commission of Internal Boundaries CONALI (2019), base maps (population centers) of the Military Geographic Institute – IGM (2012), State University of Bolívar (2022), and Bolívar province, among others; the thematic mapping was developed using Arc Gis software (10.3).

In the proposed component, action plans were designed that include measures and actions for risk reduction; and, in the management model component, the strategies and those responsible for implementation and sustainability were established; For the two components, work was done based on the review of secondary sources, interviews and workshops with territorial actors.

The risk management plans were socialized and validated with territorial actors in each parish of intervention, for this, it was coordinated jointly between the State University of Bolívar, the Secretariat of Risk Management, the GAD (Decentralized Autonomous Government) of the Chimbo canton and GAD's of the rural parishes of San Sebastián, La Asunción, La Magdalena and Telimbela, which made it possible to develop plans adapted to reality and in a participatory way that contribute to the strengthening of capacities for local security and resilience.

RESULTS

The results of the process of elaboration of the "Disaster Risk Management Plans for the Strengthening of Capacities for Community Security and Resilience" of the parishes of the Chimbo canton are presented: San José, La Asunción, La Magdalena, San Sebastián and Telimbela; They are detailed by components: diagnosis, proposal and management model.

Diagnostic component

Characterization of the territory, in table 1, it is established that the Chimbo canton has a total of 26984.7 ha (hectares), the Telimbela parish represents more than half (61.6%) of the extension of the cantonal territory, however, in the San José parish in the urban area as the capital of the canton, it registers the largest number of inhabitants, homes and dwellings. as well as infrastructure and equipment.

Table 1. Territorial extension and demographic aspects of the parishes of the Chimbo canton

Territorial level	Territorial extension (1)		Inhabitants (2)		Housing (2)		Homes (2)	
	Total in Ha	Percentage	Total	Percentage	Total	Percentage	Total	Percentage
San José Parish	1.466,7	5,4	6.020	38,8	2.320	37,2	1.833	37,8
Telimbela Parish	16.614,9	61,6	3.031	19,5	1.195	19,1	934	19,3
La Asunción Parish	3.490,0	12,9	2.745	17,7	1.188	19,0	924	19,1
La Magdalena Parish	4.356,1	16,1	2.552	16,4	1.076	17,2	788	16,3
Sebastian Parish	1.057,0	3,9	1.176	7,6	462	7,4	370	7,6
Total Canton	**26984,7**	**100,0**	**15.524**	**100,0**	**6.241**	**100,0**	**4.849**	**100,0**

Sources: (18) and (19)

Table 2 shows the employed population by branches of activity, it is observed that since most of the population is concentrated in the urban areas of the parishes, among the main economic activities of the families are based on services and commerce (retail), while agriculture is the economic base of families in rural areas.

Table 2. Population employed by branches of activity in the parishes of the Chimbo canton

Employed population by branch of activity	San Jose		Telimbela		The Assumption		La Magdalena		San Sebastian		Chimbo Canton	
	#	%	#	%	#	%	#	%	#	%	#	%
Services	1.320,0	62,6	520,0	72,2	243,0	46,0	490,0	68,3	117,0	42,1	**2.690,0**	**61,8**
Commerce	446,0	21,1	159,0	22,1	211,0	40,0	156,0	21,8	99,0	35,6	**1.071,0**	**24,6**
Agriculture and mines	139,0	6,6	22,0	3,1	46,0	8,7	47,0	6,6	46,0	16,5	**300,0**	**6,9**
Manofactura	126,0	6,0	18,0	2,5	15,0	2,8	15,0	2,1	10,0	3,6	**184,0**	**4,2**
Construction	78,0	3,7	1,0	0,1	13,0	2,5	9,0	1,3	6,0	2,2	**107,0**	**2,5**
Total	**2.109,0**	**100,0**	**720,0**	**100,0**	**528,0**	**100,0**	**717,0**	**100,0**	**278,0**	**100,0**	**4.352,0**	**100,0**

Source: (19)

Incidence of hazardous events

Table 3 presents the number and type of dangerous events of incidence in the parishes of the Chimbo canton, showing that the parishes of San José and La Magdalena register the highest number of events; With respect to the type of event, mass movements (landslides), forest and geological fires (earthquakes and volcanic activity – ash fall) have a greater presence in the cantonal territory.

Table 3. Number of dangerous events of incidence in the parishes of the Chimbo canton, period 1970 to 2024

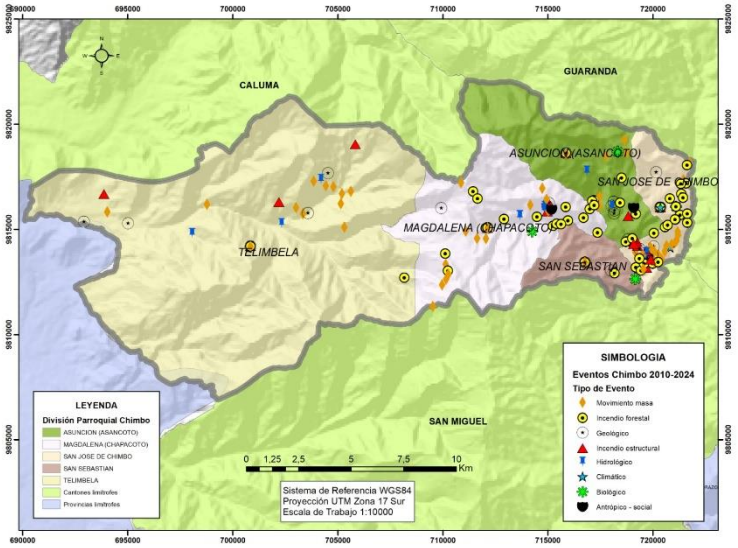
Type of Hazardous Events	San Jose	Telimbela	The Assumption	La Magdalena	San Sebastian	Chimbo Canton	
	Number	Number	Number	Number	Number	Number	%
Mass movement	40	21	7	24	2	**94**	**35,9**
Forest fire	35	4	7	22	2	**70**	**26,7**
Geological	14	5	6	6	5	**36**	**13,7**

Structural fire	10	5	2	3	0	**20**	**7,6**
Hydrological	7	6	10	0	0	**23**	**8,8**
Climate	6	0	0	6	0	**12**	**4,6**
Biological	1	0	1	1	2	**5**	**1,9**
Anthropic-social	0	0	1	1	0	**2**	**0,8**
Total	**113**	**41**	**34**	**63**	**11**	**262**	**100,0**

Source: [21] and [22];

Cartography of hazardous events, Figure 2 represents the location by types of hazardous events of incidence in the period 2010 to 2014 in the parishes of the Chimbo canton, the events registered in DESINVETAR from the period 1970 to 2009 are not included as they are not georeferenced.

Figure 2. Location by type of hazardous incident events in the canton of Chimbo, period 2010 - 2024



Source: [21] and [18]

Table 4 shows the effects/impacts of dangerous events in the canton, with a low number of deaths, however, the largest number of people affected by geological events (ashfall), climatic events (droughts) and biological events (do not include COVID-19 data); Similarly, geological events such as earthquakes cause greater damage to infrastructures (homes and educational units) and ash fall in agricultural activities; while mass movements (landslides) cause damage to the road; as well as, forest fires cause environmental impact due to the burned vegetation cover.

Table 4. Main effects of dangerous events in Chimbo canton, period 1970 to 2024

Effects of hazardous events	**Mov. en masse**	**Forest fire event**	**Geological event**	**Hydrological event**	**Structural fire event**	**Climatic event**	**Biological event**	**Anthropic-social event**	**Total**
Number of events	94	70	36	23	20	12	5	2	**262**
Deceased people	1	0	0	0	2	0	0	0	**3**
Affected people	90	0	8.761	38	40	1.072	446	4	**10.451**
Affected homes	13	0	187	22	9	8	0	1	**240**
Homes destroyed	3	0	15	2	5	0	0	0	**25**
Schools affected	1	0	18	6	0	0	0	0	**25**
Medical/health facilities affected	0	0	0	0	0	0	0	0	**0**

Damage to metro tracks	4.805	0	189	50	0	0	0	20	**5.064**
Bridges affected	3	0	1	4	0	0	0	0	**8**
Ha. lost crops	44	0	17.259	1	4	380	2.714	0	**20.402**
Ha. of burnt vegetation cover	0	5.103	0	0	0	0	0	0	**5.103**

Source: [21]

Exposure to natural and climatic hazards

Natural hazards, Table 5 shows the area in hectares (Ha) by type and level of exposure to natural hazards in the parishes of the Chimbo canton, with respect to mass movements, irregular topography, soil types, among other factors, the majority of the territory of the parishes is exposed to high levels; while, in the event of flooding, only the Telimbela parish in the lower part (subtropics) has areas susceptible to this threat; in reference to seismic hazard, the cantonal territory is located in zone III and IV of high danger determined by the Ecuadorian Construction Standard – NEC (2015).

Table 5. Exhibition of natural hazards of the parishes of the Chimbo canton

Type and level of threat		San Jose	Telimbela	The Assumption	La Magdalena	San Sebastian	Chimbo Canton	
Guy	Level	Has	Has	Has	Has	Has	Has	%
Dough movements (1)	Loud	783,7	1.5402,1	3.489,3	3.998,5	957,2	24.630,8	91,3
	Media	604,9	1212,8	0,7	191,9	89,9	2.100,2	7,8
	Casualty	78,1	0,0	0,0	165,7	9,9	253,6	0,9
	Total	1.466,7	16.614,9	3.490,0	4.356,1	1.057,0	26.984,7	100,0
Flood (2)	Loud	0,0	0,5	0,0	0,0	0,0	0,5	0,0
	Media	0,0	52,3	0,0	0,0	0,0	52,3	0,2
	Casualty	0,0	239,4	0,0	0,0	0,0	239,4	0,9
	No susceptibility	1.452,8	16.322,7	3.467,0	4.325,1	1.057,0	26.624,6	98,7
	Urban area (populated)	13,9	0,0	23,0	30,9	0,0	67,9	0,3
	Total	1.466,7	1.6614,9	3.490,0	4.356,1	1.057,0	26.984,7	100,0
Earthquake (NEC-2015 standard) (3)	Zone IV. Z-value: 0.35 g. High danger	1.466,7	182,9	2.716,9	3.417,2	1.057,0	8840,6	32,8
	Zone III. Z-value: 0.30 g. High danger	0,0	16.432,0	773,1	938,9	0,0	18.144,0	67,2
	Total	1.466,7	166.14,9	3.490,0	4.356,1	1.057,0	26.984,7	100,0

Sources: [23]; [24]; [25]

Climatic hazards, table 6 shows the exposure areas by parishes, in reference to the threat of frost, for the most part it does not present susceptibility, in the territories of the sierra (upper parts) they have very low and low levels, a minimum area of medium level; with respect to forest fires, in a large part of the territory they have low and medium levels, however, in the parishes with the exception of San Sebastián they present very high and high levels of exposure; while the threat of desertification mostly registers zero susceptibility, however, medium and low levels in the territory with the exception of Telimbela which has only a low level; It is worth mentioning, although it is not presented in Table 6, all parishes according to [26] have low levels of susceptibility to the threat of drought.

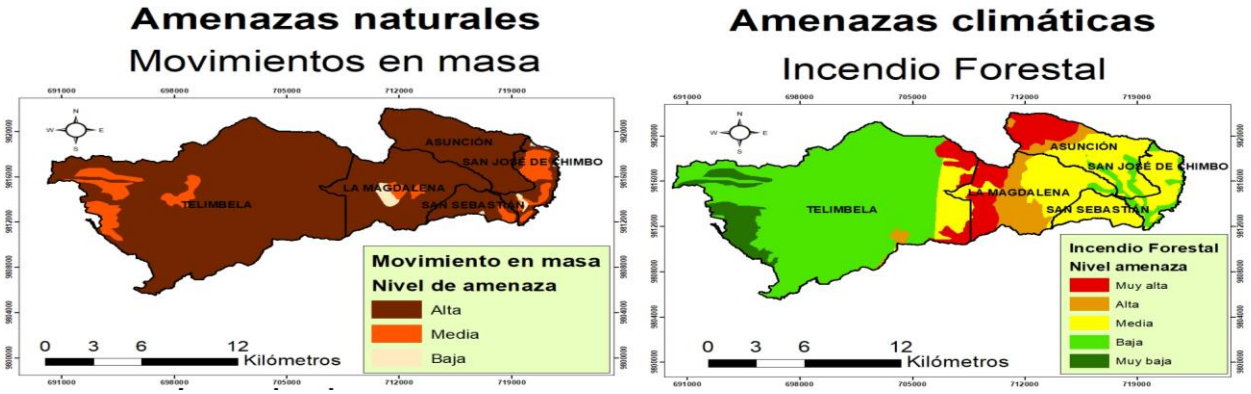
Table 6. Exhibition of climatic threats of the parishes of the Chimbo canton

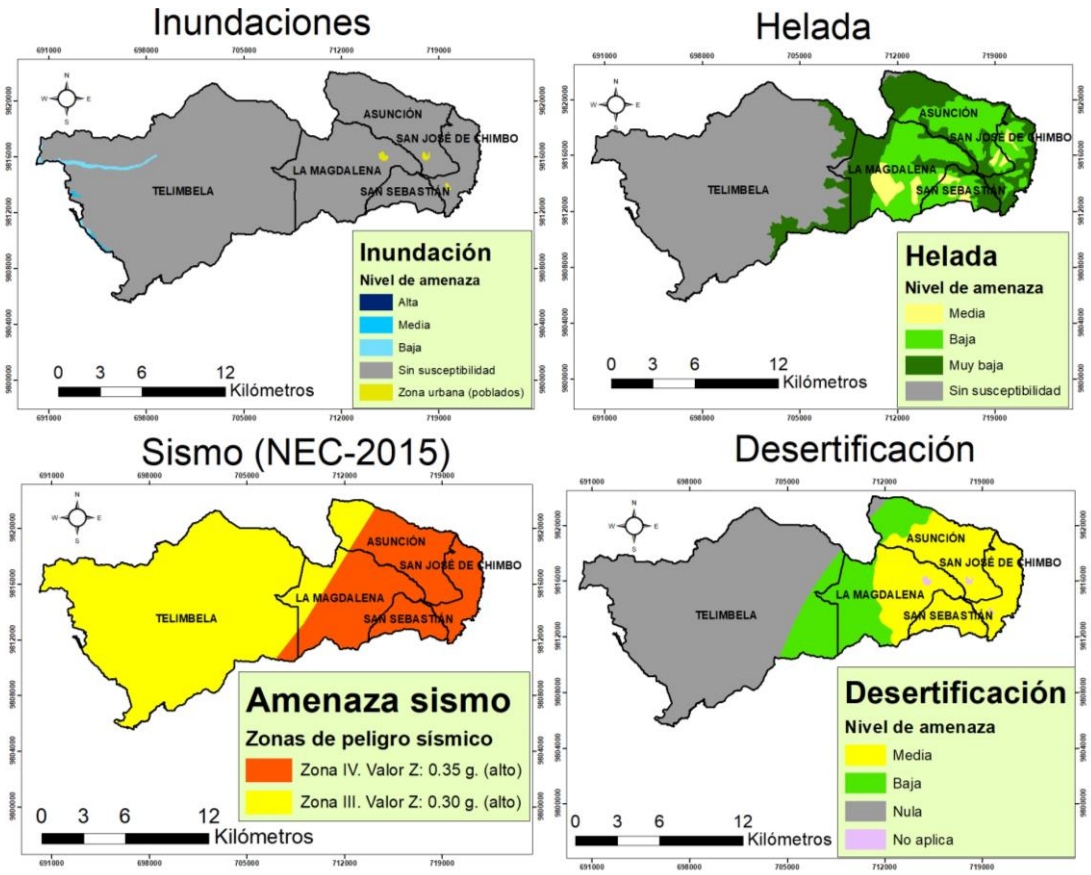
Type and level of threat		San Jose	Telimbela	The Assumption	La Magdalena	San Sebastian	Chimbo Canton	
Guy	Level	Has	Has	Has	Has	Has	Has	%
Frost (1)	Loud	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Media	68,4	0,0	73,2	502,3	171,0	814,9	3,0
	Casualty	588,4	0,0	1.675,1	2.158,0	531,4	4.952,9	18,4
	Very low	810,0	1.355,5	1.689,2	1.602,7	354,5	5.811,9	21,5
	No susceptibility	0,0	15.259,3	52,5	93,1	0,0	15.404,9	57,1
	Total	1.466,7	16.614,9	3.490,0	4.356,1	1.057,0	26.984,7	100,0
Forest fire (2)	Very high	4,2	745,4	965,8	988,9	0,0	2.704,3	10,0
	Loud	0,0	143,4	400,6	1.323,8	0,0	1.867,8	6,9
	Media	1.029,4	1.009,1	1.754,7	1.959,5	1.051,0	6.803,7	25,2
	Casualty	433,1	13.238,5	368,9	83,9	6,0	14.130,4	52,4
	Very low	0,0	1478,5	0,0	0,0	0,0	1.478,5	5,5
	Total	1.466,7	16.614,9	3.490,0	4.356,1	1.057,0	26.984,7	100,0
Desertification (1)	Loud	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Media	1.452,8	0,0	2.496,5	2.434,1	1.057,0	7.440,3	27,6
	Casualty	0,0	1.686,8	862,4	1.891,1	0,0	4.440,3	16,5
	Null	0,0	14.928,1	108,0	0,0	0,0	15.036,2	55,7
	Not applicable	13,9	0,0	23,0	30,9	0,0	67,9	0,3
	Total	1.466,7	16.614,9	3.490,0	4.356,1	1.057,0	26.984,7	100,0

Sources: [27]; [26]

Cartography of natural and climatic hazards, Figure 3 represents the maps of the main natural and climatic hazards to which the parishes of the Chimbo canton are exposed, the same ones that were described in the results of table 6.

Figure 3. Mapping of natural and climatic hazards exhibited in the parishes of the Chimbo canton





Sources:;; ; (CONALI, 2023) (SGR, 2011)(SGR, 2015)(NEC, 2015)(SGR, 2019)(GAD provincia Bolívar, 2019)

Component: Proposal

Table 7 presents the systematization of the proposal (action plans) of the disaster risk management plans for the strengthening of capacities for community security and resilience of the parishes of the Chimbo canton, including measures by risk management components (risk analysis and reduction, management of adverse events and recovery). the same that are marked by the measures that appear in the plan of each parish.

Table 7. Proposed component of the "disaster risk management plans for the strengthening of capacities for community security and resilience" of the parishes of the Chimbo canton

Action plan by disaster risk management components	San Jose	Telimbela	The Assumption	La Magdalena	San Sebastian
Risk analysis					
Detailed studies of hazards (floods, landslides, forest fires, floods, others)	x	x	x	x	x
Geological and geotechnical studies in risk areas	x	x	x		
Seismic microzoning study	x				x
Volcanic Ash Threat and Vulnerability Assessment		x	x	x	x
Vulnerability assessment of historic-heritage buildings	x			x	
Building vulnerability studies	x	x	x	x	x
Population Vulnerability and Exposure Assessment	x	x	x		
Vulnerability studies and exposure of essential infrastructure (health, water, education, others)	x				
Risk reduction (prevention and mitigation)					
Slope stabilization works	x	x	x	x	x
Retaining wall works in flood risk areas	x	x			

Cleaning and desilting of streams and rivers	x	x		x	
Protection strips in rivers and streams		x		x	
Preparation and compliance with risk regulations	x	x	x		
Reinforcement of vulnerable housing	x			x	
Hardening critical infrastructure	x		x		
Reforestation programmes in high-risk areas and fragile ecosystems (erosion, moorlands, others)	x	x		x	x
Creation of lines of defense against forest fires			x	x	
Risk Management Committees at cantonal, parish and community levels	x	x			
Incorporate in PDOT in the disaster risk component	x	x	x	x	x
Climate Change Adaptation Programs		x			
Adverse Event Management (Preparedness, Alert, and Response)					
Emergency/contingency plans for each event	x	x	x	x	x
Strengthening of cantonal COE and parish COPAE	x	x	x	x	x
Inter-institutional coordination	x	x	x	x	
Formation of emergency brigades and community lookouts	x	x	x	x	x
Safe zone signage and evacuation plan	x	x	x	x	
Training plans (authorities, institution and population)	x	x	x	x	x
Threat Monitoring	x	x	x	x	
Construction and activation of temporary shelters	x	x	x		x
Early Warning Systems for Hazardous Events	x	x	x	x	x
Equipping response agencies	x		x		x
Equipping local public institutions	x				
Simulation and drill exercises	x	x	x		x
Humanitarian assistance in the event (emergency funds)	x	x	x		x
Recovery (rehabilitation and reconstruction)					
Plans for the restoration of basic services	x			x	
Physical-Infrastructure Recovery Plans	x	x	x	x	
Economic recovery plans	x	x			
Emergency agricultural credits and/or bonds	x	x		x	x
Technical assistance to the agricultural sector		x		x	
Psychological recovery plans and medical care	x				

Note: PDOT: Development and Land Use Plan, COE: Emergency Operations Committee, COPAE: Parish Commission for Emergencies

Source: [28]

Component: Management model

In the management model component, it is proposed for the mother parish of San José, since the urban area is the capital of the Chimbo canton, the plan must be executed by the Planning and Risk Management Unit of the GAD Chimbo canton, the cantonal COE and the working groups that include the institutions with representativeness and competencies at the canton level. with the participation of the neighborhood Risk Management committees and neighborhood brigades; while, in rural parishes (La Asunción, La Magdalena, San Sebastián and Telimbela) work must be done through the Parish Commission for Emergencies – COPAE, which

is made up of the institutions and representatives of the communities, with the creation and involvement of neighborhood and community Risk Management Committees at the parish level.

For the process of implementation and sustainability of disaster risk management plans, actions are incorporated for coordination between the different levels of the territory through the cantonal COE and the COPAE of rural parishes; likewise, programs, projects, and actions must be included in local planning instruments such as the Development and Territorial Planning Plans (PDOT) at the cantonal and parish levels; in addition, strategies are included for the coordination of joint actions and technical support from the National Secretariat of Risk Management, as well as generating agreements and cooperation actions with territorial actors, such as local governments, public and private institutions, academic-scientific institutions, cooperation organizations, among others that intervene and can support the parishes and the Chimbo canton.

Socialization and validation of risk management plans

In coordination between the State University of Bolívar, the GAD canton Chimbo, the National Secretariat of Risk Management SNGR - Bolívar Provincial Unit and the GADs of the rural parishes of intervention, workshops were developed to socialize and validate the disaster risk management plans. Table 8 shows the number of participants in the workshops of each of the parishes intervened, in the parish of San José, being the cantonal capital, the workshops were led by the Mayor as president of the COE and main authority of the canton, with the participation of institutional representatives of the working groups; while, at the parish level, the workshops were led by the Presidents of the Decentralized Autonomous Government as local governments, with the attendance of representatives of the institutions that work in the territory, as well as the president and neighborhood and community leaders representing the population; in addition, the events had the technical support of technicians from the SNGR, the GAD Chimbo canton, professors and students of the Master's Degree in Risk Prevention and Management of the State University of Bolívar.

Table 8. Number of participants in workshops to socialize and validate disaster risk management plans in the parishes of the Chimbo canton

No.	Territorial level	Number of territorial actors involved
1	San José Parish	41
2	San Sebastián Parish	14
3	La Asunción Parish	26
4	La Magdalena Parish	28
5	Telimbela Parish	23
	Total Canton Chimbo	**132**

Source: [28]

DISCUSSION

The risk management plans developed in the intervention parishes in the Chimbo canton, being prepared at the local level, allow for greater detail through the diagnostic component, the incidence of dangerous events, threats and resources; in the proposal, it establishes an action plan; in the management model, the strategies for implementation and sustainability; for this reason, they are instruments for better intervention in the territories. This is related, as mentioned by [9], that national plans contain diagnoses, policies and general guidelines for intervention, however, local plans describe special characteristics and local priorities [9]. This could be corroborated with the document "Specific Risk Management Plan, 2019 – 2023", prepared by the National Risk and Emergency Management Service – SNGRE of Ecuador, which among the contents include general statistics of disaster events at the national level, as well as objectives, strategies and actions for the national scale, but does not include specifications for the local scale [29], as in the case of the parishes of the Chimbo canton where there are no detailed actions to work in the cantonal territory.

On the other hand, the development of disaster risk management plans for the parent-urban parish (San José) and the rural parishes (Telimbela, La Asunción, La Magdalena and San Sebastián) contribute to addressing the territory of the Chimbo canton in a comprehensive (urban-rural) manner; this is related to the work carried out by [30], who consider that, for the implementation of risk management plans, it should not only be based on future scenarios, but should also include criteria of justice, equity and complementarity between urban and rural areas, as in the case of watersheds, adequate management in high rural areas reduces vulnerability in downstream urban regions[30]. In the case of the populations of the Pearl River basin (China), it was evident that, despite the institutional barriers and limitations to work at the local level, it is necessary to create synergies and consensus between the inhabitants and leaders of the communities (informal actors) with the authorities and institutions (formal actors) to formulate local policies and plans for risk reduction[31]. Similarly, an integrated risk-sharing approach is required, in which institutions (public and private) and the population work in the face of complexity and uncertainty by resorting to the principles of decision science and with a social

approach to risk management[32]. Therefore, the territorial diagnoses for the Chimbo canton, as well as for all the constituencies at the local level, must consider detailed, technically and socially reliable studies.

Similarly, the risk management plans were socialized and validated with the territorial actors (community leaders, local authorities and representatives of institutions) of each of the intervened parishes, the participation and contributions of the local actors by knowing their territory better contributed to improving the information of the diagnosis, the prioritization of actions and generating commitment for the execution. This corroborates with[33], which establishes that the risk management plans prepared for the different territorial levels must have the participation of local actors who know the occurrence of the phenomena and the geographical reality, therefore, they contribute to work in greater detail for risk and disaster reduction in the territories[33]. Likewise, it should be considered that the inhabitants of areas exposed to hazards have valuable knowledge on how to prevent, adapt and mitigate disasters, therefore, it is important to recognize local knowledge as a necessary complement to scientific and technical knowledge for disaster risk reduction[34]. Similarly, it should be taken into account that community leaders contribute to a better understanding of how communities deal with disasters and contribute to the development of prevention and care strategies, in addition, they work with a vision that is more focused on the community than on the individual or family level[35].

CONCLUSIONS

The parishes of the Chimbo canton as populations located in the foothills of the western mountain range of the Ecuadorian Andes, due to their irregular topography, types of varied climates, among other factors, mainly, have been affected and are exposed to natural (mass, geological and hydrological movements) and climatic (forest fires) threats, for this reason, the development of disaster risk management plans at the local (parish) scale contribute to planning development and intervention for disaster risk reduction.

Disaster risk management plans developed at the local level make it possible to determine in better detail the incidence of dangerous events, hazards and risk conditions (diagnosis), to establish action plans adapted to reality (proposal) and to design strategies for implementation and sustainability (management model).

The participation of territorial actors with representation of the institutions and the population (managers and community leaders) for the process of elaboration, socialization and validation contribute to having risk management plans adapted to reality, generate commitments and contribute to the resilience of the populations.

The methodology developed to develop disaster risk management plans at the local scale based on the official information and cartography available, as well as the participation of territorial actors, allow for decision-making and intervention in disaster risk reduction, which will contribute to the resilience of the population and sustainability of the territories; for this reason, the experience can be replicated in other territories with similar characteristics.

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