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Impact of the cantonal risk management system on governance and natural risk reduction in Babahoyo, Ecuador

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Abstract

This study analyzes the Cantonal Risk Management System (SCGR) as a tool for reducing natural risks in the Babahoyo canton (Ecuador) during the period January 2022–September 2023. A mixed-methods approach with qualitative emphasis was applied, combining field, documentary, and descriptive analyses to evaluate institutional actors, main hazards (floods and landslides), and the management model. The results reveal a low level of implementation of strategic actions, which limits effective risk management. The multi-hazard matrix and territorial analysis identified floods and landslides as the most relevant threats, mainly associated with geographic conditions and river overflow during the rainy season. Based on these findings, a governance-oriented management model is proposed to strengthen inter-institutional coordination and improve local capacity for risk reduction.

Keywords: Risk management, floods; landslides; risk reduction, inter-institutional coordination.

Impacto del sistema cantonal de gestión de riesgos en la gobernanza y la reducción de riesgos naturales en Babahoyo, Ecuador

Resumen

Este estudio analiza el Sistema Cantonal de Gestión de Riesgos (SCGR) como herramienta para la reducción de riesgos en el cantón Babahoyo durante el período enero 2022-septiembre 2023. A través de un enfoque de métodos mixtos con énfasis cualitativo, basado en estudios de campo, documentales y descriptivos, la investigación evaluó las instituciones involucradas, las principales amenazas naturales (inundaciones y deslizamientos) y el modelo de gestión empleado. La población estudiada incluyó entidades gubernamentales, ONGs, organizaciones civiles y miembros activos del sistema, utilizando un muestreo de conveniencia enfocado en los responsables de las Unidades de Gestión de Riesgos. Los resultados revelaron un bajo nivel de implementación de las acciones estratégicas, lo que conlleva importantes limitaciones para una gestión eficaz. Adicionalmente, la matriz de riesgo y el mapa multiamenaza identificaron a las inundaciones y deslizamientos como las amenazas más relevantes, influenciadas por la ubicación geográfica y el desbordamiento de los ríos durante el invierno. Como propuesta, se desarrolló un modelo de gestión para mejorar la coordinación interinstitucional y fortalecer la capacidad de respuesta ante los riesgos naturales.

Palabras clave: Gestión de riesgos, deslizamientos de tierras, inundaciones, reducción de riesgos, coordinación interinstitucional.

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I. INTRODUCTION

Hydro-meteorological hazards such as floods and landslides have become recurrent drivers of disaster risk in many Latin American cities. In Ecuador, the interaction between a complex hydrographic network, intense rainy seasons and accelerated land-use change generates repeated emergency situations that put severe pressure on local governments and communities. Under these conditions, risk management is no longer limited to emergency response; it demands robust local governance arrangements capable of anticipating, reducing and managing risks in an integrated way. (Biass et al., 2013; Gomez-Zapata et al., 2021), (Gavilánez et al., 2020), (Taco et al., 2023). Within this framework, the Sistema Cantonal de Gestión de Riesgos (SCGR) emerges as a crucial tool to mitigate and prevent risks at the municipal level, contributing to sustainable development and community safety.

The Babahoyo canton, located in the province of Los Ríos, faces a high level of exposure to floods and landslides due to the saturation of the Babahoyo River basin and its more than 1,400 tributaries. These threats, exacerbated during winter, have had significant impacts on the local population and infrastructure (Borbor-Cordova et al., 2020). However, despite the severity of these risks, the institutions comprising the SCGR have prioritized emergency response over prevention and mitigation, reflecting an imbalance in risk management.

Among the main challenges facing the SCGR are limited budget allocation, lack of technological equipment, absence of prevention programs, and institutional disinterest (Ilbay-Yupa et al., 2021). These gaps have hindered the implementation of an integral and transversal system that ensures inter-institutional collaboration and effective coordination with the Sistema Nacional Descentralizado de Gestión de Riesgos (SNGRE). Transversality in risk management implies the coordinated participation of all stakeholders, from government institutions to civil society organizations, to comprehensively address existing threats.

In this context, the present study identifies the main natural threats, such as floods and landslides, across each area of Babahoyo canton, analyzes and diagnoses the current state of the SCGR, with the purpose of identifying key risks, as shown in Figure 1, and proposes a management model oriented towards risk prevention and mitigation. The importance of this work lies in offering practical tools and strategies aligned with the Código Orgánico de Organización Territorial, Autonomía y Descentralización (COOTAD), which assigns responsibilities to Gobiernos Autónomos Descentralizados (GADs) for disaster prevention, reaction, mitigation, and reconstruction.

Figure 1. Floods in the Babahoyo Canton

Furthermore, this study aims to strengthen inter-institutional coordination and promote the adoption of preventive measures to reduce the population's vulnerability. This approach not only addresses current threats but also aspires to build a resilient society capable of facing future climatic and geological challenges.

Against this background, the research problem

addressed in this article can be formulated as follows: *to what extent does the Cantonal Risk Management System of Babahoyo effectively contribute to local governance and to the reduction of natural risks—particularly floods and landslides—during the period January 2022 to September 2023?* This problem is approached from an analytical perspective that combines risk governance, territorial planning and multi-hazard assessment, rather than from a merely technical-administrative description of the system.

To operationalise this problem, the study is guided by the following research questions:

1. What are the main natural hazards that affect the canton of Babahoyo, and how are they spatially distributed in the territory?
2. How is the SCGR structured and what level of implementation have its strategic actions achieved in the period 2022–2023?
3. What degree of inter-institutional articulation exists among the entities that comprise the SCGR, and how does this articulation influence risk governance?
4. Which critical areas and populations concentrate the highest levels of risk, and what factors explain their vulnerability?
5. What type of management model can strengthen governance and enhance the capacity of the SCGR to reduce natural risks in Babahoyo?

Accordingly, the general objective of the research is to analyse the impact of the Cantonal Risk Management System on governance and on the reduction of natural risks in the canton of Babahoyo between January 2022 and September 2023, and to propose a management model that strengthens inter-institutional coordination and territorial resilience. The specific objectives are to:

- Characterise the multi-hazard context of Babahoyo, with emphasis on floods and landslides, through the construction of a risk matrix and a multi-hazard map.
- Evaluate the institutional architecture of the SCGR, the degree of implementation of selected strategic actions and the existing capacities in key entities.
- Quantify and interpret the degree of inter-institutional articulation among the actors involved in risk management at the cantonal level.
- Identify and classify critical sites and vulnerable populations that require priority intervention.
- Design a governance-oriented management model that mainstreams risk management into cantonal planning and decision-making processes.

The original scientific contribution of this article lies in the development and application of an integrated analytical framework that combines: (i) an assessment of risk governance and inter-institutional articulation within the SCGR; (ii) a quantitative analysis of the effectiveness of strategic actions; and (iii) a detailed territorial diagnosis based on a multi-hazard risk matrix and the identification of 39 critical sites. This approach generates empirical evidence on how a cantonal risk management system functions in practice under a decentralised governance scheme and offers a replicable methodology for other medium-sized cities in the Ecuadorian coastal region and similar contexts.

Literature Review

The management of risks associated with floods and droughts has been extensively researched due to its global relevance in the context of climate change and accelerated urbanization. Reviewed studies address various aspects of this challenge, ranging from regional analyses to methodological developments for risk evaluation and mitigation. The analysis of extreme events associated with floods and droughts highlights how risk management faces limitations in addressing unprecedented events. For instance, (Kreibich et al., 2022) demonstrates that while risk management has globally reduced vulnerabilities, it encounters significant difficulties when dealing with unprecedented events, such as those exceeding the design levels of existing infrastructure. This finding is alarming given the projected increase in extreme hydrological events due to climate change. Similarly, (Jia et al., 2022) examines flood events in the Yangtze River basin in China, revealing that although management measures have improved considerably since 1998, significant challenges remain related to urbanization and climatic variability.

At a regional level, (Sofro et al., 2024) identifies high-risk drought areas in Indonesia using clustering methods such as k-means, enabling impact anticipation and mitigation strategy proposals. This methodological approach underscores the importance of combining

advanced analytical techniques with extreme climatic data. The implementation of hydrological models and technological tools has been a recurring focus in the literature. (O. N. Shazwani, T. Wardah, 2024) describes the use of HEC-HMS with rainfall data obtained from meteorological radars to model floods in Malaysia, highlighting the need to calibrate indirect data for improved accuracy. Similarly, (Kumar et al., 2022) uses the SWAT model to identify flood risk zones in Kerala, India, integrating climatic, topographic, and ecological factors. These studies underline the importance of integrated approaches for risk assessment and the design of resilient strategies.

In Mexico, (García-Martínez et al., 2024) applies statistical distributions to analyze extreme precipitation and generate IDF curves that inform the design of drainage infrastructure in high-risk areas. This study highlights an innovative approach by considering weighted variables to improve result representativeness. The literature emphasizes the need for preventive and proactive approaches in risk management. For example, (Yang & Liu, 2020) provides an exhaustive review of risk reduction strategies for floods and droughts, emphasizing the utility of emerging technologies such as artificial intelligence and the Internet of Things.

However, many studies, such as (Rana et al., 2021) and (Almoradie et al., 2020), indicate that risk management in countries like Pakistan and Ghana remains reactive, limiting its effectiveness. These studies recommend climate change adaptation strategies and community participation to strengthen resilience. On a more local scale, (Kreibich et al., 2022) reviews flood control policies in Pakistan, concluding that despite legislative advances, no significant reduction in damages associated with these events has been achieved. Similarly, (Shah et al., 2020) highlights the importance of understanding floodplain risk dynamics and proposes criteria for selecting appropriate measures based on the specific characteristics of each region.

Identifying factors that increase vulnerability is essential for designing effective strategies. (Tariq et al., 2020) uses the IPCC framework to evaluate climate risk in indigenous communities of the Eastern Himalayas, finding that factors such as lack of land tenure and limited employment opportunities exacerbate vulnerability. In Bangladesh, (Sandoval Erazo et al., 2022) analyzes rainfall variability during the dry season and its impact on non-rice crops, concluding that rice remains a less risky option for agricultural intensification in coastal areas.

Although the reviewed studies offer valuable contributions, they present significant limitations. Most focus on regional or tool-specific approaches, lacking integrated perspectives that combine multiple risk factors and interdisciplinary approaches. Furthermore, many studies do not sufficiently consider the need to strengthen local capacities and governance structures to ensure the effective implementation of strategies (Maniruzzaman et al., 2024).

The present work addresses these gaps through the development of a holistic approach that integrates vulnerability analysis, and participatory mitigation strategies. By combining advanced tools with a deep contextual analysis, this study aims to provide more sustainable and adaptive solutions for managing flood and drought risks in vulnerable regions.

II. MATERIAL AND METHODS

The study was conducted in the canton of Babahoyo, province of Los Ríos, Ecuador. The canton is located in a low-lying floodplain characterised by the confluence of the Babahoyo River and a dense network of tributaries and drainage channels. Recurrent floods and local landslides affect both urban and rural parishes, particularly agricultural settlements located on riverbanks, embankments and unstable slopes. The analysis considered the entire cantonal territory, with special attention to the enclosures and neighbourhoods later identified as critical in the multi-hazard risk matrix.

A. Implementation Model

A descriptive and analytical study with a mixed-methods approach was adopted. Quantitative components were used to: (i) characterise the degree of inter-institutional articulation within the Cantonal Risk Management System (SCGR); (ii) build the multi-hazard risk matrix; and (iii) classify critical sites. Qualitative components were used to interpret the institutional dynamics of the SCGR, validate the strategic actions and understand the perceptions of key actors regarding governance and risk reduction. The period of analysis covers January 2022 to September 2023, which corresponds to the most recent complete hydrometeorological cycles and the implementation of the current cantonal planning instruments.

B. Action Plan

The action plan is developed in accordance with

SNGR guidelines, detailing specific objectives, goals, activities, required resources, responsible parties, and execution timelines. This approach allows for continuous monitoring and evaluation of the effectiveness of implemented actions, ensuring the progressive reduction of risks in the territory.

C. Mainstreaming Risk Management

The mainstreaming of risk management aims to strengthen the national management system by optimizing planning, implementing preventive measures, and building resilience. This model proposes:

- Including risk management within territorial planning.
- Establishing a Risk Management Unit (UGR).
- Institutional coordination with communities and external stakeholders.

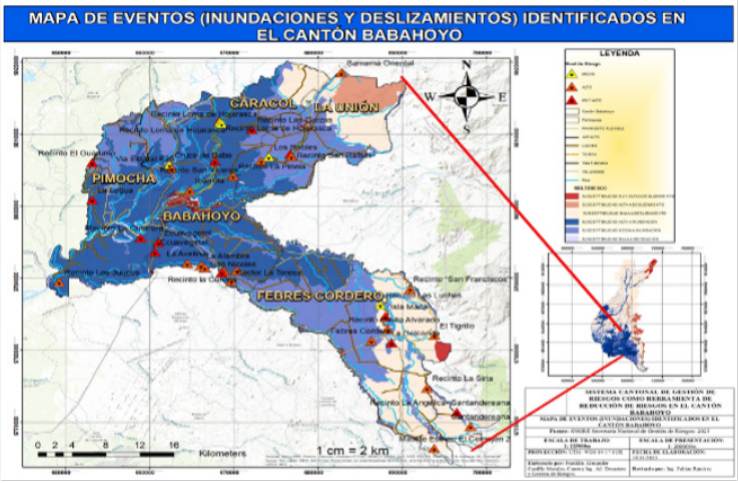

Figure 2. Map of flood and landslide events identified in the Babahoyo canton.

D. Structuring Risk Management Units

Risk Management Units (UGRs) are structured based on institutional needs, considering their mission, vision, and objectives. Regular evaluations are proposed to ensure relevance and adaptation to changing conditions. This approach is supported by Article 140 of the COOTAD, which mandates GADs to adopt technical norms for risk prevention and management.

E. Monitoring Hazardous Events

This unit is responsible for observing, recording, and analyzing hazardous events in the territory, alerting authorities and the population to potential threats. Using reliable information, it enables early warnings to protect communities.

F. Preparedness and Response

The preparedness and response unit plans and coordinates actions to protect lives, health, the environment, and property. This includes activating contingency plans, mobilizing resources, and restoring basic services during emergencies.

G. Risk Reduction

A detailed analysis of existing risks is proposed, prioritizing prevention and mitigation measures to reduce vulnerability. This approach includes:

- Prevention: Raising awareness and educating in disaster-prone areas.
- Mitigation: Implementing corrective measures to reduce the impact of threats.

H. Inter-Institutional Coordination

Tools such as Technical Working Groups (TWGs) are used to plan, execute, and evaluate actions. These groups address issues such as safe water, health, basic services, and humanitarian assistance.

I. Emergency Operations Committee (COE)

The COE, structured into five components (decision-making, technical implementation, operational support, information management, and infrastructure support), coordinates emergency responses, ensuring efficient and synchronized operations among stakeholders.

Semi-structured interview guides and a structured questionnaire were applied to representatives of the

institutions included in Table 1. The instruments collected information on: organisational structure, human and material resources, participation in the Emergency Operations Committee (COE), coordination mechanisms, implementation of strategic actions and perceived weaknesses and strengths of the SCGR.

- Validation: the guides and questionnaire were reviewed by three experts (two academics specialised in risk management and one technician from the national risk management service) to ensure content validity, clarity and relevance of the items. A pilot application with a small group of officials allowed minor wording adjustments before the full application.
- Application: interviews were conducted face to face or virtually, recorded with prior consent and transcribed for analysis. The questionnaire was applied using digital forms and, in some cases, printed formats, ensuring that each participating institution provided a single consolidated response.

III. RESULTS

The research results focus on three specific aspects to consolidate the proposal based on designing a management model that mainstreams risk management within a Cantonal System. This system comprises the actors involved in the prevention, response, and recovery from adverse events. The key findings are as follows:

A. Current Situation of the SCGR

The research focuses on identifying the members of the SCGR and their roles in the territory when facing an adverse event. While guidelines established by the SNGRD exist, territorial realities vary depending on the context. This section evaluates the current circumstances related to the SCGR in Babahoyo, with a particular focus on the institutions that comprise it. Surveys were conducted with key administrators and members of the organizational structures of these entities.

This analysis captures perceptions, challenges, and strengths within the system, providing an informed foundation for introducing strategies and improvements. The evaluation represents a critical stage for optimizing the SCGR's capacities, enhancing its effectiveness in mitigating the inherent risks in Babahoyo. The entities identified to strengthen the proposal are presented in Table 1.

Table 1. Entities identified

Governing Body	Secretaria Nacional de Gestión de Riesgos (SNGR)
Cantonal GAD	Risk Management Unit (UGR) of Babahoyo Canton
	Grados de libertad (df)
Parish GADs	UGR of Febres Cordero Parish GAD
	UGR of La Unión Parish GAD
	UGR of Caracol Parish GAD
	UGR of Pimocha Parish GAD
Member Organizations	Fire Department
	Rights Protection Council or Ombudsman Office
	Health Sector
	Education Sector
	Economic and Social Inclusion
	Housing Sector
	National Police
	Strategic Sectors (CNEL)
	Red Cross
	Traffic Agency
	Armed Forces
Invited Members	International Cooperation in the Territory
	Provincial GAD of Los Ríos
	Babahoyo Technical University

B. Strategic Actions

Once the SCGR stakeholders were identified, two of the nineteen strategic actions were identified to determine their impact within the present research topic; among them, Strategic Action 1 is carried out in order to evaluate the threats present in the territory as detailed in Table 2 below.

Table 2. Strategic Action 1

Indicators	Frequency	Percentage
0: Strategic action not executed	3	18.75%
1: Historical records of hazardous events in a database	6	37.5%
2: Threat reports with alphanumeric and geographic data	5	31.25%
3: Technical report on threats	1	6.25%
4: Specialized threat studies	0	0%
5: Specific threat studies linked to an IDE	1	6.25%
TOTAL	**16**	**100%**

Subsequently, Strategic Action 6 is detailed, whose main objective within the project is to institutionalize and regulate risk management, as shown in Table 3.

Table 3. Strategic Action 6

Indicators	Frequency	Percentage
0: Strategic action not executed	4	25%
1: Ordinance for establishing the Risk Management Unit or its equivalent	7	43.75%
2: POA for the operation of the Risk Management Unit or its equivalent	1	6.25%
3: Resolution/regulation establishing risk reduction policies	0	0%
4: Report on executed contracts for risk management, payment receipts	1	6.25%
5: Ordinance establishing the Cantonal System	3	18.75%
TOTAL	**16**	**100%**

Based on the documentary analysis and interviews, the strategic actions defined at national level were contrasted with the activities actually implemented in Babahoyo. From this process, the actions most directly related to governance strengthening and risk reduction were selected—specifically, Strategic Action 1 and Strategic Action 6. For each action, a catalogue of activities and responsible entities was elaborated. Implementation level was classified into three categories: "implemented", "in progress" and "not initiated".

For each strategic action, a **degree of implementation** was calculated as:

$$\text{Implementation (\%)} = \frac{\sum_{k=1}^{m} w_k \ a_k}{\sum_{k=1}^{m} w_k} \times 100$$

where a_k is the implementation status of activity k (1 = implemented; 0.5 = in progress; 0 = not initiated) and w_k is a weighting factor that reflects its relevance. The results are presented in Tables 2 and 3.

According to the findings, several entities have a moderate involvement in hazard assessment and documentation of historical events. This facilitates the implementation of specific measures related to risk management. Given that the responsibility for this competence is decentralized, more accountable entities, such as the municipal government, are required. This role is crucial when other institutions disengage from these responsibilities, considering that risk management is a cross-cutting initiative that requires rapid action in the face of adverse events.

The methodology focuses on analyzing the degree of articulation and relationships between the entities that make up the cantonal SCGR. This aspect is fundamental to identify suitable collaborators and facilitate the adoption of effective measures, promoting collaborative participation during an adverse event. The analysis shows favorable results, with 75.7% effectiveness according to a cross matrix of inter-institutional interrelationships as detailed in Table 4.

Table 4. Degrees of articulations and their effectiveness

Indicators	Frequency	Percentage
Low	6	1.57%
Medium	86	22.63%
High	288	75.78%
TOTAL	**380**	**100%**

The identification of hazards is shown in detail in Table 5, identifying 39 sites in the Babahoyo canton with their respective incidents and level of risk.

Table 5. Identification of enclosures and their hazards

N.	Location	Site	Incident	Risk Level
1	La Siria Road, La Providencia	La Siria Site	Undermining of the road.	HIGH
2	San Juan de Las Malvinas	San Juan Las Malvinas	Loss of a wall, damage to 2 houses, water intrusion into more than 6 houses.	HIGH
3	Drain - Las Malvinas	Las Malvinas Site	Damaged drain; partial weakening of an asphalt road.	HIGH
4	Febres Cordero Road - Mata de Cacao	Febres Cordero	Collapse of a drain and structural damage to the road.	HIGH
5	El Guarumo Site	El Guarumo Site	Flooding caused by the Pueblo Viejo River.	VERY HIGH
6	"San Francisco" Site	"San Francisco" Site	Loss of a protective wall.	HIGH
7	Las Luchas Site	Las Luchas Site	Loss of a protective wall.	MEDIUM
8	Section I - San Jacinto Entrance	Ecuavegetal	Damage to a 50-meter entrance at Ecuavegetal.	VERY HIGH
9	Section II - Jujan, near Eduardo Mill	Ecuavegetal	Damage to 25 meters near Eduardo Mill.	VERY HIGH
10	María Island	María Island	Water intrusion into houses, minor flooding in 9 houses in the area.	VERY HIGH
11	La Chorrera Stream	La Chorrera Site	Flooding affected houses, increasing the likelihood of further damage.	VERY HIGH
12	Protective Wall	Emilia Alvarado Site	Breakage of a protective wall, flooding, and water intrusion into several houses.	HIGH
13	Carriageable Wall	La Valdivia Site	Breakage of a carriageable wall due to rising levels of the Clementina River.	VERY HIGH
14	Section I, Vulnerable Housing	Loma de Hojarasca Site	Identified breakage of a protective wall.	HIGH
15	Section II Protective Wall	Loma de Hojarasca Site	Identified breakage of a protective wall.	MEDIUM
16	Section III Protective Wall	Loma de Hojarasca Site	Breakage of a protective wall with several weakened points identified.	MEDIUM
17	Flooded Road	Ibarrola Site	Flooded road sections, leaving approximately 10 families isolated.	HIGH
18	Canal without Flow	Las Garzas Site	Las Garzas Site is affected by a canal currently lacking protective walls.	VERY HIGH
19	Containment Wall and Flooded Roads	San Vicente Site	San Vicente Site is one of the most affected areas due to its location.	VERY HIGH
20	Road Collapse	La Pinela Site	Road section collapse, hindering mobility for residents of the area.	HIGH

21	Road Connecting Two Sites	La Angélica-Santandereana	Loss of passage between La Angélica and Santandereana Sites.	VERY HIGH
22	Drain Collapse	La Corona Site	Drain collapse due to heavy rainfall in the area.	HIGH
23	Road	Baba Crossing	Partial damage to a road section.	MEDIUM
24	Drain Collapse	State Road E25	Drain damage in the area caused by heavy winter rainfall.	HIGH
25	Cacharí Hill Road	Los Robles	Road sections under water.	MEDIUM
26	Jujan River	Los Juncos Site	Flooding of access roads, leaving several families isolated.	HIGH
27	Mata de Cacao Road	La Teresa Sector	Sinkhole on the asphalt road, near a drain.	HIGH
28	Chilintomo River	Los Álamos Site	Flooding due to the breakage of a protective wall.	VERY HIGH
29	Pita River	San Rafael Site	Overflow of the Pita River.	HIGH
30	Pueblo Viejo River	La Legua Site	Weakening of the protective wall and overflow of the Pueblo Viejo River.	VERY HIGH
31	Clementina River Overflow	La Puntilla Site	Overflow of the river.	VERY HIGH
32	Drain Collapse	Matilde Esther/El Comején 2	Increased water flow in the area due to heavy rainfall.	HIGH
33	Protective Wall Collapse and Erosion	La Golconda	Erosion of natural protective walls caused by Las Juntas River.	VERY HIGH
34	Protective Wall Collapse	La Avelina Site	Erosion and collapse of protective walls.	HIGH
35	Erosion of Protective Walls	Samama Oriental	Damage due to progressive erosion of protective walls.	HIGH
36	Chilintomo River Overflow	La Alambra Site	Damage, loss, and erosion of a protective wall, leaving approximately 50 families exposed.	HIGH
37	Chilintomo River Overflow	San Nicolás Site	Partial erosion of protective walls, leaving at least 19 families exposed.	HIGH
38	Landslide	El Tigrillo Site	Heavy rainfall caused landslides on certain slopes.	HIGH
39	Landslide	Santandereana Site	Heavy rainfall caused partial road landslides.	HIGH

Inter-institutional articulation within the SCGR was analysed using a relational matrix in which each cell A_ijrepresents the existence of a coordination link between institutions iand *j*. A link was considered present when institutions: (i) jointly participated in the COE; (ii) co-implemented prevention or response activities; or (iii) shared formal cooperation agreements or protocols.

From this matrix, the global articulation index was calculated as:

$$\text{Articulation (\%)} = \frac{L_{\text{obs}}}{L_{\text{max}}} \times 100$$

where L_{obs} is the number of observed links and L_{max} =n(n-1)/2is the maximum possible number of links for ninstitutions. This index, which in Babahoyo reached **75.78** %, quantifies how dense and interconnected the SCGR network is. Degrees of articulation and their qualitative interpretation are summarised in Table 4, and Figure 3 shows the resulting inter-institutional network

The geographic context reveals that the area in question is characterized by a greater susceptibility to risks, which is mapped in Fig 2, mainly associated with flooding phenomena, which negatively affect essential services, contribute to the collapse of retaining structures, displace affected households and aggravate river overflows and increased water flows. These conditions underscore the need to strengthen the capacities of risk management institutions, involving both direct and indirect entities.

In addition, most of the documented incidents occur in areas classified as high risk, especially near rivers and tributaries. The lack of risk awareness among families and communities increases the severity of impacts, mainly affecting those who depend on agricultural activities.

C. Axes of the model

The management framework emphasizes inter-institutional collaboration to improve interrelationships and facilitate effective responses to adverse events. This approach aims to strengthen coordination among the entities involved, promoting integrated and timely actions that minimize risks and strengthen the resilience of the cantonal system. This framework is characterized by the orientation presented in Table 6.

Table 6. Risk management model axes

Mainstreaming Risk Management in Babahoyo		
Creation of the Risk Management Unit	Inclusion of risk management within territorial planning	Institutional articulation with communities and external actors

This proposal focuses on the organizational configuration of the Cantonal Government, which contemplates the integration of Risk Management as an advisory entity with a cross-cutting perspective. This approach seeks to ensure the effective incorporation of Risk Management in all areas of competence, thus contributing to a more comprehensive and coordinated management of risks in the Canton's governmental sphere.

These results indicate that the SCGR is still at an **incipient stage** in terms of systematic hazard assessment. Although there is a minimum information base on past events, very few institutions produce detailed analyses or integrate geospatial information in a way that supports territorial planning and decision-making. From a governance perspective, this limits the capacity to prioritise interventions and to design preventive measures beyond emergency response.

Regarding Strategic Action 6 (Table 3), 25 % of entities report that the action has not been executed, whereas 43.75 % have an ordinance to establish a Risk Management Unit or its equivalent. However, only 6.25 % have a specific annual operating plan (POA) for the UGR, and another 6.25 % report contracts or executed investments in risk management. No entity reports the existence of formal resolutions or regulations that establish risk reduction policies, and only 18.75 % mention an ordinance formally creating the Cantonal System.

D. Articulation and capacity building

The articulation and strengthening of capacities in risk management aim to integrate social, institutional, and community actors to efficiently address emergencies. The first step is to promote coordination spaces with key stakeholders, such as Community Coordination Networks, to align objectives, define roles, and foster inclusive participation in planning and decision-making. This creates cohesion among involved parties, enabling quick and effective responses to risk situations.

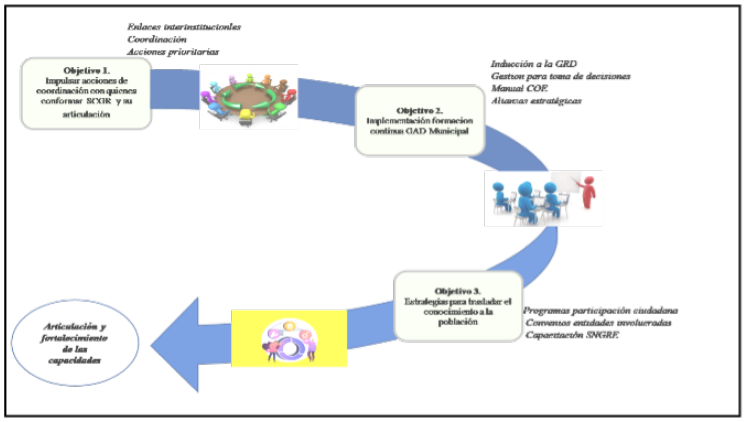

Figure 3. Interinstitutional Articulation

Institutional strengthening focuses on the continuous training of municipal GADs, equipping them with technical tools to assess risks, manage emergencies, and plan resiliently. This training includes practical workshops, drills, and the use of advanced technologies, ensuring that local authorities have the capacity to implement preventive measures and lead effective responses.

Quantitative data from questionnaires and matrices were processed using spreadsheets and statistical software. Descriptive statistics (frequencies, percentages and cross-tabulations) were employed to characterise institutional capacities, implementation of actions and levels of articulation. The relational matrix was analysed using basic network measures (density and degree) and visualised as a graph to highlight key actors and coordination gaps.

Qualitative information from interviews and field observations was subjected to thematic content analysis, coding responses into categories related to governance, coordination mechanisms, perceived risks and challenges. The convergence between quantitative indicators and qualitative narratives was used to interpret the functioning of the SCGR and to support the design of the management model.

Finally, processes of shared responsibility with the population are established, actively involving them in risk management through awareness campaigns, training community leaders, and promoting a culture of prevention. This enables communities to take a proactive role in risk mitigation, reducing the impact of disasters and ensuring sustainable collaboration with local institutions.

IV. DISCUSSION

The results obtained in Babahoyo confirm that the effectiveness of local risk management systems cannot be explained solely by the presence or absence of formal institutions. Rather, it depends on the interaction between institutional capacities, the density and quality of inter-institutional relationships and the way in which these arrangements are translated into concrete actions in the territory. In this sense, the configuration of the Cantonal Risk Management System (SCGR) in Babahoyo reflects trends reported in other Latin American and Global South contexts, where decentralisation has formally assigned responsibilities to local governments, but institutionalisation and operational capacity remain uneven across territories.

The analysis of Strategic Actions 1 and 6 illustrates this “implementation gap”. On the one hand, Babahoyo has created Risk Management Units (UGR) and has incorporated the topic into certain municipal structures, which aligns with national regulations and with the emphasis on local governance promoted by international frameworks. On the other hand, the low proportion of entities that produce detailed hazard assessments or maintain specific operating plans and budgets for risk management shows that these advances are still fragile. Similar patterns have been reported in other medium-size cities, where risk management is often subordinated to short-term political cycles and is treated as a cross-cutting issue without clear instruments, dedicated staff or stable funding. In Babahoyo, this situation limits the capacity of the SCGR to move from a reactive approach, centred on emergency response, to one that prioritises prospective and corrective risk reduction.

The high global inter-institutional articulation index (75.78 %) provides an interesting counterpoint. At first sight, this value suggests a relatively robust governance network, with frequent coordination among key actors, especially around the Emergency Operations Committee (COE) and response operations. However, a more detailed examination reveals asymmetries within the network: some institutions maintain strong and recurrent links, while others—particularly those related to social sectors, community organisations or certain parish governments—occupy more peripheral positions. This configuration is consistent with the idea of "response-centred governance", where coordination is activated primarily during emergencies and is dominated by actors with operational resources (fire brigades, police, municipal services), whereas prevention, land-use regulation and social participation are less institutionalised. The Babahoyo case thus confirms that a dense network is not necessarily synonymous with effective risk reduction if its operation is not aligned with long-term planning and equity criteria.

From the territorial perspective, the identification of 39 critical sites with high and very high multi-hazard risk reinforces the argument that risk is socially and spatially produced, rather than merely given by natural conditions. Many of the sites correspond to riverbanks with long-standing problems of bank erosion, failure of protection works and occupation of flood-prone zones, as well as hillsides with inadequate drainage or road embankments exposed to instability. The recurrence of damage and the cumulative deterioration of infrastructure indicate that structural measures have been partial, palliative or poorly maintained. This pattern has also been documented in other floodplains and low-lying agricultural areas, where productive pressures and housing demands lead to settlement in high-risk zones in the absence of effective land-use control and viable relocation alternatives. The Babahoyo findings therefore support the need to integrate multi-hazard risk criteria into cantonal development and land-use plans, rather than limiting interventions to post-event reconstruction.

The convergence between institutional and spatial analyses is particularly relevant. The concentration of very high-risk sites along river corridors and in rural enclosures with limited access to services coincides with weaker institutional presence and fewer formal coordination mechanisms at the local level. This suggests that current governance arrangements are more effective in the urban core and in highly visible infrastructures than in dispersed or marginalised rural communities, which tend to accumulate greater vulnerability. From a governance perspective, this underscores the importance of strengthening parish GADs, community organisations and sectoral agencies that operate in these territories, as well as of creating mechanisms for their effective participation in planning and decision-making spaces.

V. CONCLUSION

This study analysed the impact of the Cantonal Risk Management System (SCGR) on governance and the reduction of natural risks—especially floods and landslides—in Babahoyo canton between January 2022 and September 2023. The findings show that the existence of a formal risk management structure is a necessary but not sufficient condition to ensure effective risk reduction at the territorial level.

First, the research confirms that Babahoyo has a broad institutional base for risk management, which includes national agencies, the municipal and parish governments, sectoral entities and support organisations. This configuration responds to the decentralisation framework established in Ecuador and provides a potentially favourable ground for risk governance. However, the analysis of Strategic Actions 1 and 6 reveals that institutionalisation is partial and uneven: although several Risk Management Units have been formally created, only a small group of entities develop detailed hazard assessments, specific operating plans or budgetary instruments dedicated to risk management. As a result, the SCGR still operates predominantly under a reactive logic, with emphasis on emergency response rather than on prospective and corrective risk reduction.

Second, the inter-institutional articulation index of 75.78 % indicates a relatively dense coordination network, particularly around the Emergency Operations Committee and response operations. Nonetheless, the presence of medium and low articulation links and the asymmetric positioning of some actors show that the network is not homogeneous. Coordination is strongest among institutions directly linked to emergency response and urban services, while it is weaker with community organisations, certain parish governments

and social sectors. This pattern suggests a form of response-centred governance, in which interaction intensifies during emergencies but is less consolidated in planning, prevention and long-term territorial management.

Third, the multi-hazard analysis identified 39 critical sites with high and very high levels of flood- and landslide-related risk. These sites are mainly concentrated along riverbanks and in areas with unstable slopes or deficient drainage. The recurrence of damage—such as erosion and collapse of protective structures, flooding of dwellings and agricultural land, and periodic road failures—indicates that existing interventions have been insufficient, fragmented or weakly maintained. Risk is thus reproduced over time through the interaction between hazardous conditions, exposure of infrastructure and settlements in inappropriate locations, and socio-economic vulnerability of rural and peri-urban communities.

Fourth, the convergence between institutional and territorial analyses indicates that the areas with the highest accumulated risk tend to coincide with territories where institutional presence and inter-institutional coordination are weaker. This finding suggests that current governance arrangements are more effective in the urban core and in highly visible infrastructures than in dispersed rural communities and smaller settlements. Addressing this imbalance requires strengthening parish-level governance, promoting community participation and improving the integration of risk criteria into local development and land-use plans.

Fifth, based on these results, the article proposes a management model for Babahoyo organised around four axes: (i) institutional strengthening and normative consolidation of the SCGR; (ii) prospective and corrective risk reduction, including structural and non-structural measures; (iii) preparedness and response, with improved early warning and operational coordination; and (iv) citizen participation and community resilience. The model's contribution lies in articulating improvements in institutional architecture and inter-institutional relationships with the prioritisation of interventions in the most critical sites identified by the multi-hazard matrix, thereby operationalising the principles of the Sendai Framework at the cantonal scale.

From a practical standpoint, the study highlights several policy implications: (i) the need to consolidate risk management as a sustained municipal function, with specific ordinances, operating plans and budget lines; (ii) the importance of strengthening technical capacities for hazard assessment and geospatial analysis to support risk-sensitive territorial planning; (iii) the urgency of designing and implementing integrated intervention programmes in the 39 critical sites, combining infrastructure works, land-use regulation and community preparedness; and (iv) the relevance of promoting mechanisms that ensure the effective participation of rural and peri-urban communities in planning and decision-making processes.

VI. CONCLUSION

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