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Prioritization of Territorial Areas for Implementing Inclusive Climate Risk Transfer Mechanisms. Colombia as a Case Study.

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Abstract The methodologies for prioritizing populated areas regarding the implementation of risk transfer schemes are still limited due to the exclusion of social components. This research proposes a methodology for prioritizing territorial areas when implementing Climate Risk Transfer Mechanisms (CRTM) using the differential risk transfer approach and considering three Colombian regions as a case study. In order to achieve this, we carried out a literature review to identify existing related methodologies. We targeted components such as gender, ethnicity, poverty, exposure and governance. Workshops were also conducted to generate a multisectoral agreement concerning the variables to be included in the multicriteria analysis. Subsequently, we produced a ranking system applying the criteria to 12 departments both with and without Climate Change (CC) conditions. The results of our investigations showed that there are no records of methodologies for prioritizing areas that include variables of vulnerability and governance. The CC rankings indicated modifications to the previous rankings. The prioritized departments thus highlighted were La Guajira, Bolívar, Chocó, Magdalena, San Andres and Sucre. This research applied differential risk transfer to successfully improve the accuracy of the risk transfer mechanism and provides a methodological guide for optimizing technical and financial resources in the decision-making process for CRTM. This methodology is especially useful for territorial areas with low technical and economic capacities and can be replicated worldwide since the data is available through open access.

Keywords: Colombia, climate risk management, disaster reduction, differential risk transfer, prioritization, socioeconomic vulnerability

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1. INTRODUCTION

Many countries have included *risk transfer* in their Disaster Risk Management (DRM) planning instruments, aiming to reduce the socioeconomic vulnerability to climate-related hazards (Matheswaran 2019; Fernández 2020; Hagenlocher 2020). Risk transfer refers to the process of allocating the financial consequences of risk from one part to another (formal or informally), creating a system in which resources are obtained from the other part following the occurrence of a disaster and thereby providing social and financial benefits (Cardona 2009). Internationally, risk transfer is considered one of the five pillars of DRM: (i) Risk identification. (ii) Risk reduction. (iii) Preparedness. (iv) Financial protection (including risk transfer). (v) Resilient recovery (DRFIP 2020). According to Miles and Wiedmaier-Pfister (2019), risk transfer is a DRM process that aims to reduce inequalities through innovative approaches (*e.g*., gender-sensitive climate risk insurance) in regions with high levels of socioeconomic vulnerability to disasters. This serves to underline the relevance of climate risk transfer for the DRM actions on the international agenda.

Although there is a clear understanding of the benefits and features of Climate Risk Transfer Mechanisms (CRTM), the development of inclusive approaches and their practical application is still limited. According to Fernández *et al.* (2022a), only the gender-specific approach is included in risk transfer strategies. Other relevant factors such as ethnicity, life cycle and disabilities, are not as yet being considered. Various authors (Granés *et al.* 2019) recommend a differential approach as a comprehensive process for reducing socioeconomic vulnerability to disasters. The differential approach refers to a set of actions that seeks recognition of specific vulnerabilities for each population group and pursues the means by which they can be reduced (Arteaga *et al.* 2012). The inclusion of a differential approach in the design of CRTM contributes to recognizing local needs and fills the data gaps that limit the potentiality of such mechanisms. Fernández *et al.* (2022a) highlight the Differential Risk Transfer (DRT) approach and provide methodological guidelines for its implementation at the subnational level. DRT is defined as the 'process of transferring the financial consequences of risk from one part to another, considering the characteristics of gender, ethnicity and life cycle of an individual, family or community, in the activities related to the design and implementation of mechanisms that allow the access of obtaining social or financial benefits when a climate-related disaster strikes' (Ibid, pp2).

Even though previous research puts forward guidelines for implementing DRT, there is no evidence of its application in a specific context. In fact, there are few signs of progress in implementing methodologies prioritizing activities related to climate DRM and risk transfer worldwide (de Brito *et al.* 2017; Samuel *et al.* 2019; Khatri-Chhetri *et al.* 2019; Hauge *et al.* 2020; Sarmiento & Torres-Munoz 2020). Matheswaran *et al.* (2019) identified potential zones for piloting flood insurance in India. However, this study does not take into consideration socioeconomic vulnerability variables/indicators as selection criteria. Hagenlocher *et al.* (2020; 2018) identified the level of risk and readiness for implementing climate risk insurance of small island developing states, outlining a ranking system through

the InsuRisk Assessment tool. Despite this, it fails consider specific social variables of gender and ethnicity within the vulnerability component.

According to IRGC (2017), risk governance refers to the institutional structures and sociopolitical processes that guide collective activities thereby seeking to influence risk issues. Risk governance is represented through the capacities of the institutions for understanding and reducing risk as well as their readiness when a disaster strikes. A relevant component of risk governance is the regulatory framework and planning capacities, which in practice translates into public policies and planning instruments, respectively (Klinke & Renn 2019). Consequently, governance should be considered as the component that allows the implementation of risk transfer activities as well as guaranteeing their sustainability.

Prior to defining methodological components for the prioritization process, we carried out a literature review aiming to identify methodologies related to the prioritization of territorial areas. Such activity made clear that there are no records of methodologies for prioritizing territorial areas that include both the gender and ethnic approach as well as governance variables along with those of hazards and exposure and institutional and technical aspects that make the risk transfer process feasible. As such, it is pertinent to define a set of variables that include gender, ethnicity and governance as innovative criteria for decision-making. These criteria should include variables that reflect features of Colombian global vulnerability, namely institutional, socioeconomic, cultural and physical vulnerability (Wilches-Chaux 1989). Such criteria should allow for the prioritization of areas with a comprehensive DRM approach. Consequently, the main objective of this research is to design and apply an inclusive methodology for prioritizing territorial areas suitable for implementing a CRTM, taking specific regions of Colombia as a case study. To achieve this, in the following sections we provide an overview of the governance and risk conditions of Colombia in the following sections before presenting the three regions where the criteria will be applied. Subsequently, we present the methodological outline along with the multisectoral agreement of factors and variables before concluding with a ranking of the prioritized territorial areas both with and without Climate Change (CC) conditions. Our conclusions and recommendations for future implementations serve to complete this research paper.

1.1 Colombia as a Case Study

The Latin American and Caribbean (LAC) region is characterized by high levels of inequality among different social groups. Income disparities are also reflected spatially among rich and poor sub-national areas, which are referred to as municipalities or departments. Moreover, the fact that Latin America is one of the most urbanized regions in the world has contributed to a concentration of job and income opportunities in cities and the impoverishment of rural areas, while cities have seen an increase in informal settlements as well as urban poverty (Sandoval *et al.* 2019; Sandoval & Sarmiento 2020). Hence, innovative methodologies and original ideas on prioritizing territorial areas with a view to implementing

a CRTM are not only necessary but clearly fundamental as these may contribute to a strategic and rational use of scarce resources in developing countries.

Given our focus on the LAC region context, we considered Colombia as a case study since DRM is widely regulated, with the country having carried out an integral approach to DRM that includes risk transfer as one of its fundamental components (Congress of Colombia 2012; UNGRD 2015). In terms of public policies, risk transfer presents relevant progress at the (sub)national level. The country has four departmental financial protection strategies that are aligned with international and national DRM public policies (Fernández *et al.* 2022b).

Colombia is particularly vulnerable to floods, droughts and tropical cyclones. The country exhibits a trend towards increased reporting of disasters produced by socio-cultural dynamics related to environmental deterioration triggered by climate-related events (Marulanda *et al.* 2010). Compared to other LAC countries, Colombia displays an intermediate level of adaptability to climate risk -compared to the other LAC countries- (Nagy *et al.* 2018). According to the Congress of Colombia (2019), in the course of 19 years, materialized 3,000 disaster events materialized from which 88% (2,443) were triggered by climate-related hazards. In Colombia, the most representative hazards are floods (37%), droughts (35%), mass movement (15%) and flash floods (1%). The Norwegian Refugee Council –NRC– (2020) asserts that floods, mass movement, wildfires and tropical cyclones activated more than 35,000 internal displacements in Colombia during 2019. Furthermore, projections predict an increase in the country's average annual rainfall (near 30%) due to Climate Change (CC) (Reyer *et al.* 2017).

For this paper, the Colombian regions of Pacífica, Caribe and Insular of Colombia (Figure 1) have been selected with the aim of developing guidelines provided by Fernández *et al.* (2022a) in a particular territorial context. These three regions present low socioeconomic indicators and high levels of exposure to climate-related hazards. They are also prioritized in the National

Figure 1. Location of the Colombian Regions: Pacífica, Caribe and Insular

Development Plans of Colombia (2014-2018 and 2018-2022) due to a critical need for civil protection and sustainable development. The three regions are composed of 12 departments. According to Campos *et al.* (2012), these regions have, historically, been those most vulnerable to floods, droughts and tropical cyclones.

1.2 Main Characteristics of the Selected Regions

The Insular region is composed of one department (San Andrés-Providencia-Santa Catalina). The region has a comparatively low rate of monetary poverty (8.6%) –the poverty rate in Colombia is 27%– and has increased on average 32% over the last ten years. The population growth has increased three times more in the last 20 years when compared with last century (DANE 2019). This region contains 25% of the informal settlements in high-risk areas and is the most vulnerable to rises in sea levels (Climate Central 2019) as well as drinking water shortages (IDEAM 2018). Moreover, it has the lowest capability regarding CC adaptation in the country (DNP 2020).

The Caribe region is composed of seven departments: La Guajira, Magdalena, Cesar, Atlántico, Sucre, Bolívar and Córdoba. This region represents the second highest level of social inequality and the lowest level of economic development. Cesar, Sucre, Bolívar and Córdoba are the departments with the lowest level of efficiency in communication, transport, electricity and drinking water coverage. The region also has 20 municipalities coming under the category of 'high risk of flooding' (UNGRD 2018). In La Guajira, 53% of the population live in poverty, followed by Magdalena (48.5%) and Córdoba (45%) (DANE 2019).

The third region, Pacífica, is composed of four departments: Chocó, Valle del Cauca, Cauca and Nariño. This region has significant levels of inequality levels compared to others. For example, 32.1% of its population (three out of ten people) is in monetary poverty (DANE 2019). This figure is above the national average (27%). On the other hand, the regional authorities have stated that DRM is considered a priority process in their sustainable development plans.

Although Colombia may be considered a pioneer on risk transfer public policies at the territorial level, the country still lacks clear selection criteria for prioritizing areas when implementing CRTM. Thus, this research aims to provide a methodological discussion informing (sub)national authorities, multilateral organizations and international donors how to optimize technical and financial resources in the decision-making process.

2. METHODOLOGY

Figure 2 illustrates the methodological structure for prioritizing territorial areas. It identifies information sources as well as the definition and multisectoral-agreement of the

different variables that compound the factorizing of the ranking system, aiming to rank the most suitable territorial areas for implementing a DRT mechanism. The sections that follow describe the selected factors, variables and weightings. In Figure 2, exposure is included within vulnerability, given that being located in hazard-prone areas increases the susceptibility of a community to hazard impacts. In the same way, governance (or lack of) is a subset of vulnerability since a deficiency in institutional structures and sociopolitical processes of a particular territorial area could increase the susceptibility of a community to hazard impacts. Wilches-Chaux (1989) has explained this as physical vulnerability (exposure) and institutional/political vulnerability (a lack of governance).
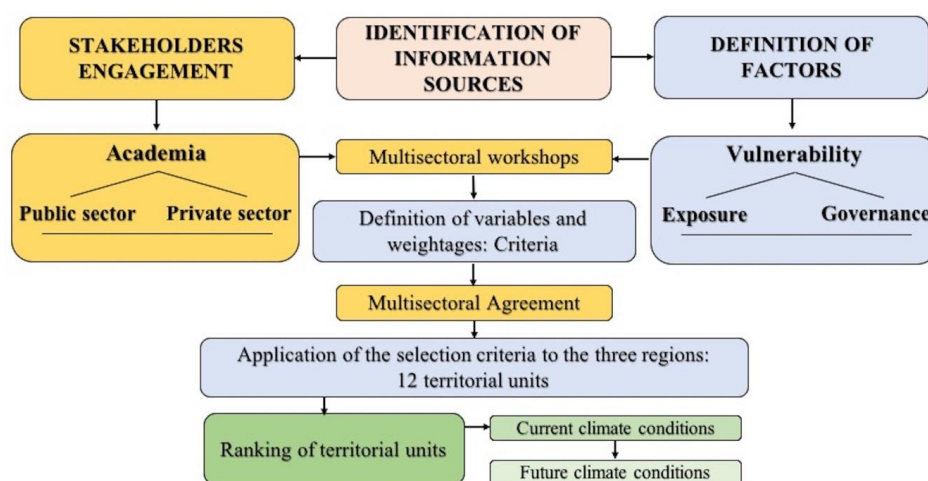
Figure 2. Methodological Scheme for Prioritizing Territorial Areas Applying the Differential Risk Transfer Approach.

2.1 Factors

The selection criteria included three factors: Vulnerability, Exposure and Governance. These factors display features of the disaster risk conditions of the territorial areas. They address social conditions, financial resources, hazard impacts/recurrence and institutional capabilities for DRM. Each factor was represented through official indicators and data furnished by the (sub)national authorities. These factors provided a comprehensive and systemic scope of socioeconomic vulnerability relating to CRTM as they are not based solely on monetary factors or expected losses. In the same way, financial capacity does not refer solely to the capability for implementing a CRTM, but also includes legal support, technical capabilities, planning instruments and institutional will (Klinke & Renn 2019). Likewise, the territorial areas with highest risk were generally considered unsuitable, as this may facilitate an adverse selection in the markets, thus rendering a CRTM non-viable (Wagner 2020). Consequently, prioritizing a territorial area implies an inclusive multidimensional scope,

where comprehensive factors such as Vulnerability, Exposure and Governance are taken into consideration.

We carried out a multi-criteria decision analysis using a simple scoring method (Brixner *et al.* 2017), with weightings assigned to the selected variables and factors. Within each department, we employed an additive scoring method for the three factors since it is an adequate approach in this context given its convenience for territorial areas with low technical capacities and resources, while considering the complexity and multiple criteria involved in the ranking of variables. The weighting permitted the incorporation of the DRT approach in the prioritization process. The variables took as a reference the set of social vulnerability indicators presented by Fatemi *et al.* (2017), while the Governance factor took as a reference the variables on financial protection that compound the risk management index applied in Colombia (Carreño *et al.* 2006).

2.2 Multisectoral Agreement

The weighting of variables, presented below, was defined by the authors utilising components of the DRT and socioeconomic vulnerability indexes. Subsequently, such variables were discussed and agreed upon in three multisectoral workshops. The workshops aimed to arrange and agree on the variables and their respective weightings with national and international stakeholders. The institutions involved included academia (The National University of Colombia –UNAL–), the public sector (the National Unit for Disaster Risk Management –UNGRD– and the Ministry of Finance and Public Credit); and the private sector (the Microinsurance Catastrophe Risk Organization –MiCRO–).

UNAL was represented by Dr Omar Darío Cardona, who led the pioneer process of designing and implementing a risk transfer mechanism for private property insurance in the municipality of Manizales, Colombia (Salgado-Gálvez 2017). This private inclusive risk transfer scheme has been the only one successfully implemented in Colombia.

In accordance with decree 2147/2011 and act no. 1523/2012 (Congress of Colombia 2012), UNGRD is the national authority of DRM in Colombia. It is responsible for coordinating the National System for DRM and promoting the implementation of DRM at the national level. UNGRD, in conjunction with the local authorities, has implemented the institutional strengthening program on risk reduction and financial protections; thus, this institution appreciates the capacities and needs of the Colombian territory regarding risk transfer.

In accordance with Act No. 1955/2019 (Congress of Colombia 2019), the Ministry of Finance of Colombia is charged with designing the national strategy for disaster risk finance. The ministry promotes the management of risk transfer instruments within the (re)insurance and capital markets. Jointly with the National System for DRM, it has designed six financial protection strategies that set out the risk transfer priorities at the territorial level. The

ministry's participation has contributed to identifying data and variables for a comprehensive prioritization.

MiCRO is an international organization with expertise in inclusive risk transfer. This company has worked in the LAC region since 2011, bringing together DRM and insurance products to the population groups excluded from traditional insurance products. Since 2019, MiCRO has worked in Colombia, developing inclusive risk transfer products (in harmony with the DRT approach) (MiCRO 2022). This experience has contributed to identifying data and variables (from a private viewpoint) for making the risk transfer mechanisms feasible in practice.

The individuals, namely representatives from each institution, were selected according to their professional background, expertise in DRM/risk transfer and experience in working at the (sub)national level. The selection of the individuals took into consideration gender (UNAL and MiCRO= male; UNGRD and Ministry of Finance= female) seeking to achieve a balance, while the language of the multisectoral workshops was Spanish since all the participants are native Spanish speakers.

Table 1. Factors, Variables and Weightings without Multisectoral Agreement.

Factor 1: Vulnerability. Score: 6	
Variable	**Weight**
Presence of ethnic groups.	0-0.5
Percentage of the gender wage gap.	0-2
Incidence of multidimensional poverty.	0-3
Incidence of monetary poverty.	0-0.5
Factor 2: Exposure. Score: 2	
Variable	**Weight**
Presence of two or more climate-related events.	0-0.55
Event recurrence.	0-0.3
Impacts of the events.	0-1.2
Factor 3: Governance. Score: 4	
Variable	**Weight**
Incorporation of risk transfer in the DRM plan.	0-0.75
Hierarchy of the DRM authority in the territorial unit.	0-0.50
Existence of DRM fund and creation of a financial protection account.	0-0.80
Progress in the operationalization of the risk transfer strategy.	0-1
Risk transfer or financial protection processes in planning instruments.	0-0.95
Total Score	12

The workshop was carried out through virtual means in February 2021, with the authors presenting the predefined factors, variables and respective weightings, allowing each stakeholder to validate and evaluate the weighting of variables. All the stakeholders were equally involved in the process and given the same time for discussion and validation. The maximum value of the total factor score for each department was 12, which corresponded to the number of departments. We defined the score by assigning values according to the relevance of each factor in the DRT framework. The Vulnerability factor was the most relevant, followed by the Governance factor. Table 1 presents the predefined factors, variables and weightings (not agreed with the actors) as selection criteria.

2.3 Variables

The selected variables were represented by open data available through international/national agencies. The comparative indicators are generally available for free in all least developed countries. There is an international understanding that the indicators included refer to social vulnerability to disasters.

Considering that the three regions have lower socioeconomic conditions and are exposed to climate-related events, we created sets for the 12 departments. These sets displayed asymmetric data (compared to the other Colombian regions) within the variables considered in the selection criteria. To score the criteria in the weighting process, we used the median of the 12 departments for each variable as a reference. The variables had a predominant score according to their relevance in the feasibility of implementing a CRTM when considering the DRT approach. The sum of the score criteria could not exceed the maximum value of its respective variable.

The following describes the variables and their respective weightings.

Presence of ethnic groups: Refers to a representative number of ethnic groups as a percentage of the total population. For Colombia, we considered ethnic groups as indigenous, black and afro-descendant communities - raizal and Palenque. The weighting, defined by the authors, displays the percentage of the total population recognizing themselves as a particular ethnic group in 2020 (with 13% being the median of the 12 departments). Consequently, the weighting defined by the authors was $0 = < 12.9\%$; $0.3 = 13\text{-}27.9\%$; $0.5 = > 28\%$.

Percentage of the gender wage gap: Refers to the difference between wages earned by men and women. The gender wage gap increases the socioeconomic vulnerability of women to climate-related hazard (De Silva and Kawasaki 2018). The weighting defined by the authors displayed the percentage of the wage gap by department (with 19% being the median of the 12 departments). $0 = 0\text{-}10.9\%$; $1 = 11\text{-}19.1\%$; $2 = > 19.1\%$.

Incidence of multidimensional poverty: Measured through the Multidimensional Poverty Index, this variable identifies multiple shortages at the household and individual levels. De

Silva and Kawasaki (2018) consider such an index as an approximate measurement of socioeconomic vulnerability to disasters. The weighting took into account the percentage incidence of multidimensional poverty by department (with the median of the 12 departments being 33%): 0 = 0-16.9%; 1 = 17-33.9%; 2 = 34-50.9%; 3 = ≥ 51%.

Incidence of monetary poverty: Represents the percentage of the population with incomes below the poverty threshold. The median of the 12 departments was 51%. The weighting was: 0= ≤ 29.9%; 0.3= 30%-59.9%; 0.5= ≥ 60%.

Presence of climate-related hazards: Refers to the presence of floods, droughts and tropical cyclones. The weighting was as follows: 0 = the territorial area is exposed to only one kind of hazard; 0.3 = exposed to two types of hazards; 0.55 = exposed to three types of hazards.

Event recurrence: Based on the Consolidate Emergency Dataset (UNGRD 2021). The weighting refers to the occurrence in the last 23 years (1998-2021) of at least two types of hazards. This period was chosen as a consequence of the availability of data. The median of the 12 departments was 553. The weighting was: 0 = 0-299 events; 0.1 = 300-599 events; 0.2 = > 600-799 events; 0.3 = >800 events.

Impacts of events: Based on the Consolidate Emergency Dataset (UNGRD 2021). Takes the percentage of the population affected over the last 23 years. The median of the 12 was 68%. This analysis was based on the VISOR-database and was classified as follows: 0= ≤ 49.9% of the population likely to be affected; 0.3= 50-68.9%; 0.6= 69-89.9%; 1.2=≥90%.

Incorporation of risk transfer in the DRM plan: The defined weighting for this variable was: 0 = the DRM plan does not include risk transfer; 0.55 = the DRM plan includes financial protection; 0.75 = the DRM plan includes risk transfer.

Hierarchy of the DRM authority in the territorial area: Refers to autonomy in the decision-making process. The defined weighting was: 0= the DRM authority depends on another agency/secretary; 0.50= the DRM authority depends directly on the mayor's or governor's office.

Destination of financial resources relating to risk reduction and existence of a financial protection account: Relates to whether the DRM institution recognizes the topic as relevant or not. The weighting of this variable was: 0 = the territorial unit does not have a DRM fund; 0.4 = the territorial unit has a DRM fund with resources for risk reduction activities; 0.80 = the territorial unit has a DRM fund with a financial protection account.

Financial protection strategy, risk transfer actions and level of implementation: Refers to the weighting of variables relating to whether there is a risk transfer or financial protection strategy or not and if there are signs of progress in its implementation. Hence, the weighting assigned to this variable was: 0 = no financial protection strategy; 0.4 = an intention to design a strategy in the short term; 0.8 = the existence of a strategy; 0.1= the existence of a road map for implementation.

Financial protection inclusion in the Departmental Development Plan: Relates to risk transfer not simply being an issue for DRM authorities. As such, it was considered relevant to identify and weigh its inclusion (or otherwise) in the departmental development plan. The weighting defined for this variable was 0= the plan does not include DRM and/or financial protection; 0.45= the plan includes DRM activities; 0.95= the plan contains financial protection activities.

2.4 Future Climate

The decision was taken to include CC scenarios in order to address limitations in the projections of strategic plans and decisions in the private sector, as well as to promote prospective interventions within the public policies of DRM.

Thus, after applying the selection criteria, we considered CC scenarios (IDEAM 2015) that aimed at establishing a new ranking system of future priorities for implementing CRTM. We appraised the results of the CC vulnerability/risk evaluation presented by IDEAM (2017) and which incorporates the dimensions of hazard, sensitivity and adaptive capacity. According to IPCC (2014), sensitivity relates to the level of positive or negative affectation of a system due to CC while adaptive capacity refers to the ability of systems to adjust to potential damage or to respond to consequences. Thus, using the dimensions of sensitivity and adaptive capacity, the vulnerability component can be calculated. This component, in association with the hazard dimension, provides an estimation of CC risk.

The study takes as a reference the scenario generated by the Representative Concentration Pathway (RCP) 6.0, with a temporal scope of 2011-2040. It reveals a national ranking of the 32 Colombian departments divided by weightings for the following risk categories: Very High, High, Middle, Low and Very Low. The weightings assigned to the categories were added to the rankings for current climate conditions and were as follows: Very High = 2; High = 1.5; Middle = 1; Low = 0.5; Very Low = 0.

3. RESULTS

3.1 Multisectoral Agreement

The definition of variables and weightings arrived at through the three multisectoral workshops changed slightly the predefined variables stated by the authors. The significant changes in the type of variables came from the public sector, which focused on the Governance factor, as shown in Table 2.

3.1.1 Factors

Academia and the public sector agreed that the factors of Vulnerability and Governance should have the same value (5) while Exposure should have the predefined value of 2. They argued that the Governance Factor assures the viability of DRT implementation. The private sector sought to increase the value of the Exposure factor from 2 to 3. We decided not to take this suggestion on board since the DRT approach focused on vulnerability/capabilities rather than physical vulnerability. The multisectoral agreement thus established the factor values as follows: Vulnerability= 5; Exposure= 2; Governance=5.

3.1.2 Variable

Table 2 shows the agreed variables listed from 'a' to 'l', and the differences in weightings by actor as well as the final weightings. Below we present the changes made by each actor.

National University of Colombia (UNAL): The discussion here focused on the variables as an interpretation of the socioeconomic vulnerability of territorial units. This actor does not change the pre-defined variables.

National Unit for Disaster Risk Management (UNGRD): This actor changed the variable of a financial protection strategy by 'inclusion of the financial protection in the departmental development plan'.

Ministry of Finance and Public Credit (MHCP): This actor proposed changes in the Governance factor including: The DRM plan incorporating themes on financial protection, the hierarchical level of the DRM authority in the territorial area, the directing of financial resources for the risk reduction process and existence of a financial protection account, the existence of a financial protection strategy and implementation level and the inclusion of financial protection in planning instruments as well as political will. We do not include political will as a variable since it must be addressed in future research on the perceptions of the DRM/risk transfer authorities for implementing a CRTM.

Microinsurance Catastrophe Risk Organization (MiCRO): This actor did not change the predefined variables but increased the weighting of Governance and the weightings of the factors.

Table 2. Weightings by variables, actors and factors prioritizing territorial areas suitable for implementing a differential risk transfer mechanism. UNAL: National University of Colombia. UNGRD: National Unit for Disaster Risk Management. MFPC: Ministry of Finance and Public Credit. MiCRO: Microinsurance Catastrophe Risk Organization.

Agreed Variables		Weightings by Actor					Agreed Factor
		UNAL	UNGRD	MFPC	MiCRO	Agreed Weighting	
a	Presence of ethnic groups	0-1				**0-1**	Vulnerability 5
b	Percentage of the gender wage gap	0-1				**0-1**	
c	Incidence of multidimensional poverty	0-2				**0-2**	
d	Incidence of monetary poverty	0-1				**0-1**	
e	Presence of two or more climate-related hazards	0-0.55			0.5	**0-0.5**	Exposure 2
f	Events recurrence	0-0.65			1.5	**0-0.3**	
g	Impacts of the events	0-0.80			1	**0-1.2**	
h	The disaster risk management plan incorporating financial protection	0-1	0-2	0-1	0-1	**0-1**	Governance 5
I	Hierarchical level of the disaster risk management authority	0-0.5	0-0.5	0-1	0-1	**0-0.5**	
J	Destination of financial resources and existence of a financial protection account	0-2	0-1	0-0.5	0-0.5	**0-2**	
K	Existence of a financial protection strategy and implementation	0-1	0-1	0-2	0-0.5	**0-1**	
L	Inclusion of the financial protection in the Departmental Development Plan	0-0.5	0-0.5	0-0.5	0-1	**0-0.5**	
TOTAL							12

3.2 Applying the Selection Criteria

We present here the variable weightings (Figure 3) and arguments for their inclusion in each criterion in the 12 departments. The weightings follow the ranks described in Table 2.

3.2.1 The Insular Region

San Andrés, Providencia and Santa Catalina: 42.2% of the total population (63,692 people) is ethnic and the wage gap is 13%. Multidimensional poverty has an incidence rate of 8.9% while monetary poverty is 27%. Hence, the Vulnerability factor is 1.5. The region is exposed to floods, droughts and tropical cyclones, recording 18 events in the last 23 years that have affected 49.5% of the population. The Exposure factor is 0.5. The DRM plan includes risk transfer (pp.118-141), the DRM Office depends on another secretary, a DRM fund (with resources) is in place as well as a financial protection account. The department has a financial protection strategy without signs of significant progress and the development plan includes DRM activities (p.252) but does not include risk transfer. The Governance factor is 3.75. **The total factor score is 5.75.**

3.2.2 The Caribe Region

La Guajira: Ethnic groups represent 6.3% of the total population (965,718). The wage gap stands at 29.6%, the incidence of multidimensional poverty is 51.4% while monetary poverty is 61.8%. The Vulnerability factor is 4. Within the department 170 events were caused by the three kinds of hazards, resulting in 122.3% of the population being affected. The Exposure factor is 1.7. The DRM plan incorporates risk transfer (pp.80-97) and the DRM Office does not depend on another secretary. There is a DRM fund and a financial protection account, but no financial protection strategy is as yet in place. The development plan includes DRM activities (p.125). Hence, the Governance factor is 3.75. **The total factor score is 9.45**.

Magdalena: 7.5% of the population (1,427,026) is ethnic. The wage gap represents 17.8%, the incidence of multidimensional poverty is 38.6% with monetary poverty at 53.5%. The Vulnerability factor is 2. The department is exposed to all kinds of hazards. 615 events affected 116% of the population. The Exposure factor is 1.9. The DRM plan incorporates risk transfer activities (p.127) while the DRM Office does not depend on another secretary. A DRM fund is in place alongside a financial protection account. There is no financial protection strategy. The development plan includes DRM activities (p.125-184). The Governance factor is 3.75. **The total factor score is 7.65**.

Cesar: The ethnic population represents 11% of the total (1,295,387), the wage gap is 17.8%, the incidence of multidimensional poverty is 38.6% and monetary poverty stands at 51.7%. The Vulnerability factor is 2. The department is exposed to all three kinds of hazards,

having been impacted by 536 events causing damage to 68% of the total population. The Exposure factor is 0.9. The DRM plan incorporates risk transfer (p.127) and the DRM office does not depend on another secretary. There is a DRM fund with resources but no financial protection account or financial protection strategy. The development plan includes DRM (p.87). Therefore, the Governance factor is 2.75. **The total factor score is 5.65**.

Atlántico: 5.1% of the total population (2,722,128) recognize themselves among the ethnic groups. The gender wage gap is 19.5%, multidimensional poverty represents an incidence of 20.1% and 27.3% of the population is experiencing monetary poverty. The Vulnerability factor is 1.5. All three kinds of hazards affected the department numbering 464 in total and affecting 18.7% of the population. The Exposure factor is 0.6. The DRM plan incorporates risk transfer (p.130), the DRM office depends on the Interior Secretary and the department has a DRM fund (with resources) as well as a financial protection account. There is no financial protection strategy, but the development plan does include DRM (p.296). However, there is no risk transfer. The Governance factor is 3.25. **The total factor score is 5.35**.

Sucre: Ethnic groups represent 10.8% of the total population (949,252) and the gender wage gap is 19.6%. The incidence of multidimensional poverty is 39.7% and monetary poverty stands at 50.3%. Hence, the Vulnerability factor is 2.5. The department is exposed to all three kinds of hazards, with 443 events occurring in the last 23 years affecting 104.9% of the total population. The Exposure factor is 1.8. The DRM plan incorporates risk transfer (p.100), but there is no DRM office. However, there is a DRM fund and a financial protection account. While no financial protection strategy exists, the development plan does include DRM (p.470). The Governance factor is 3.25. **The total factor score is 7.55.**

Bolívar: Ethnic groups represent 14.6% of the total population (2,180,976). The gender wage gap stands at 13.8%, the incidence of multidimensional poverty is 32.4% and the incidence of monetary poverty is 46%. Consequently, the Vulnerability factor is 2. There are three kinds of hazards with 822 records of disasters/emergencies that affected 100% of the population. The Exposure Factor is 2. The DRM plan incorporates financial protection (p.95) and the DRM office does not depend on another secretary. There is a DRM fund with a financial protection account but no financial protection strategy; however, the development plan does include activities related to DRM (p.200). The Governance factor is 3.75. **The total factor score is 7.75**.

Córdoba: The ethnic population represents 5.6% of the total population (1,828,947). The gender wage gap is registered at 23.3%, the incidence of multidimensional poverty is 36.7% with monetary poverty at 54.2%. Consequently, the Vulnerability factor is 2.5. The department is exposed to floods and droughts with 643 events having been recorded in the last 23 years affecting 68% of the population. The Exposure factor is 0.75. The DRM plan incorporates risk transfer (p.103) but there is no DRM office. There is a DRM fund with a financial protection account. While there is no financial protection strategy, the development

plan does include DRM (p.27-33). The Governance factor is 3.25. **The total factor score is 6.5**.

3.2.3 The Pacífica Region:

Chocó: 62% of the total population (544,764) is classified as ethnic. The gender wage gap is negative (-10.2%), which means women are the predominant earners. The multidimensional poverty incidence is 45.1% while the incidence of monetary poverty is 68.4%. The Vulnerability factor is 3. The territory is affected by floods and droughts, recording 792 events in the last 23 years and affecting 100% of the population. The Exposure factor is 1.65. The DRM plan incorporates financial protection, with the DRM office depending on the Interior Secretary. There is a DRM fund but no financial protection strategy. The departmental development plan includes risk transfer (p.367). The Governance factor is 2.5. **The total factor score is 7.15**.

Valle del Cauca: 14.3% of the total population (4,532,152) recognize themselves as belonging to an ethnic group. The gender wage gap represents 21.5%, the incidence of multidimensional poverty is 13.6% and monetary poverty extends to 24% of the population. The Vulnerability factor is 1.5. The department is exposed to floods and droughts, recording 828 events that have affected 10.3% of the total population. The Exposure factor is 0.55. The DRM plan incorporates risk transfer (p.73). The DRM office does not depend on another secretary and possesses a DRM fund without a financial protection account. There is an intention, in the short term, to formulate a financial protection strategy and the development plan includes DRM. The Governance factor is 3, and **the total factor score is 5.05**

Cauca: The ethnic population represents 16.4% of the overall population (1,491,937). The gender wage gap is 4.9%, the incidence of multidimensional poverty is 28.7% while the incidence of monetary poverty is 59.6%. The Vulnerability factor is 1.5. The department is exposed to floods and droughts recording 547 events that have affected 47.8% of the population. The Exposure factor is 0.35. The DRM plan incorporates risk transfer (p.206) and the DRM office is linked directly to the Governor's office. A DRM fund is in place, but no financial protection account exists. The DRM authority intends to formulate a financial protection strategy in the short term and the development plan includes DRM (p.137). The Governance factor is 3, and t**he total factor score is 4.85.**

Nariño: 14.3% of the total population (1,627,589) recognize themselves as belonging to an ethnic group. The gender wage gap represents 14.3%, the incidence of multidimensional poverty is 33.5% and monetary poverty stands at 51%. The Vulnerability factor is 2. The department is exposed to floods and droughts, recording 559 events in the last 23 years that have affected 32.3% of the total population. The Exposure factor is 0.35. The DRM plan fails to incorporate risk transfer. The DRM office is linked directly to the Governor's office and there is a DRM fund but no financial protection account. There is also no financial protection

strategy, but the departmental development plan does include DRM (p.138). However, there is no risk transfer. The Governance factor is 1.75. **The total factor score is 4.1**.

Variables: a=Presence of ethnic groups. b=Percentage of the gender wage gap. c= Incidence of multidimensional poverty. d=Incidence of monetary poverty. e=Presence of two or more climate-related hazards. f=Events recurrence. g=Impacts of the events. h=The disaster risk management plan incorporates financial protection. i=Level of the hierarchy of the disaster risk management authority. j=Destination of financial resources and existence of a financial protection account. k=Existence of a financial protection strategy and implementation. l=Inclusion of the financial protection in the Departmental Development Plan.

W= Weight.   D= Department.

a W 0.5 D: Nar, Val, Cau, Bol.	W 1 D: San, Cho.	**e** W 0.25 D: San, Mag, Cor, Cho, Val, Cau, Nar.	W 0.5 D: LaG. Ces, Atl, Suc, Bol.	**i** W 0 D: San, LaG. / W 0.5 D: Mag, Ces. Suc, Bol, Val, Cau, Nar.
b W 0.5 D: San, Mag, Bol, Nar.	W 1 D: LaG, Ces, Atl, Suc, Cor, Val.	**f** W 0.1 -0.2 D: San, LaG, Mag, Ces, Atl, Suc, Cor, Cho, Cau, Nar.	W 0.3 D: Bol, Val.	**j** W 1 D: Ces, Suc, Cho, Nar, Val, Cau. / W 2 D: San, LaG. Mag, Atl, Bol, Cor.
c W 0.5 -1 D: San, Mag, Ces, Atl, Suc, Bol, Cor, Cho, Cau, Nar.	W 2 D: LaG.	**g** W 0 D: San, Ces, Suc, Cor.	W 1.2 D: LaG. Mag, Bol, Cho.	**k** W 0.5 D: San, LaG, Mag, Val, Cau. / W 1 D: none.
d W 0.5 D: San, Mag, Ces, Suc, Bol, Cor, Cho, Cau, Nar.	W 1 D: LaG. Cho.	**h** W 0 D: Ces, Atl, Suc, Bol, Cau.	W 1 D: San, LaG. Mag, Cor, Cho, Val.	**l** W 0.25 D: San, LaG, Mag, Ces, Atl, Suc, Bol, Cor, Cho, Val, Cau, Nar / W 0.5 D: none.

Atl= Atlántico. **Bol**= Bolívar. **Cau**= Cauca. **Ces**= Cesar. **Cho**= Chocó. **Cor**= Córdoba. **LaG**= La Guajira. **Mag**= Magdalena. **Nar**= Nariño. **San**=San Andrés, Providencia y Santa Catalina. **Suc**= Sucre. **Val**=Valle del Cauca.

Figure 3. Weightings Attributed to Each Variable by Department.

3.3 Ranking of Territorial Units

The development of the selection criteria as outlined above enables the elaboration of a ranking system displaying the most suitable departments for implementing a CRTM. Table 3 summarizes the prioritized departments with number 1 indicating the most suitable.

The most suitable departments for implementing a CRTM are located in the Caribe region, namely La Guajira, Bolívar, Magdalena, Sucre and Córdoba. The Pacífica region includes the department of Chocó in the top six. These results, as presented above, are strongly influenced by the Vulnerability factor, with the Caribe region scoring lower on the socioeconomic indicators. In the Caribe and Pacífica regions, higher levels of socioeconomic vulnerability are exhibited in the departments of La Guajira and Chocó (Figure 4). The standard error of the variables from the vulnerability factor according to Figure 3 is ±: a = 4.95%, b = 2.33%, c = 3.59% and d = 4.16%.

The Exposure factor influences the Caribe region significantly since it is vulnerable to floods, droughts and tropical cyclones. The impact of events in the department of Chocó is

noteworthy as 100% of the population have been affected four times by floods in the last 23 years. Extreme events producing severe impacts have also taken place in La Guajira (tropical cyclones and droughts), Magdalena, Bolívar and Sucre (through flooding and droughts). The standard error of the variables from the Exposure factor according to Figure 3 is ±: e = 0.04, f = 0.03 and g = 0.17.

Table 3. Ranking of Departments Suitable for Implementing a Climate Risk Transfer Mechanism with a Differential Approach (Number 1 (colored in red) indicates the most suitable)

No	Region	Department	Factor Score
1	Caribe	La Guajira	9.45
2	Caribe	Bolívar	7.75
3	Caribe	Magdalena	7.65
4	Caribe	Sucre	7.55
5	Pacífica	Chocó	7.15
6	Caribe	Córdoba	6.5
7	Insular	San Andrés, Providencia, Santa Catalina	5.75
8	Caribe	Cesar	5.65
9	Caribe	Atlántico	5.36
10	Pacífica	Valle del Cauca	5.05
11	Pacífica	Cauca	4.85
12	Pacífica	Nariño	4.1
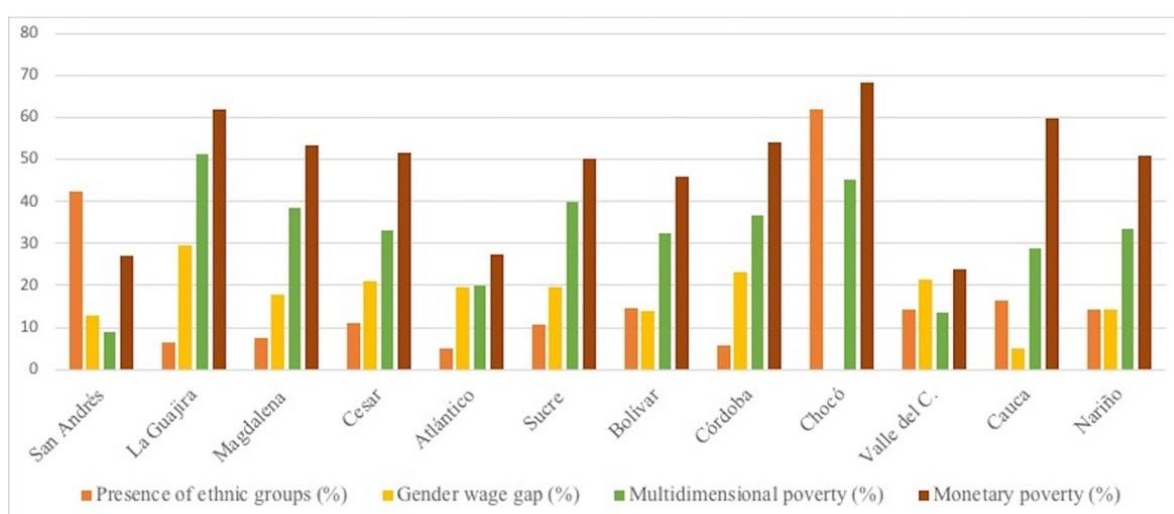
Figure 4. Percentage of the Comparative Indicators (Variables) Included in the Vulnerability Factor by Department (Note the Negative Wage Gap in the Department of Chocó)

The departments with the highest Vulnerability factor, as presented in Figure 5 are La Guajira, Chocó, Sucre and Córdoba. The departments with the highest Exposure factor are Bolívar, Magdalena, Sucre and La Guajira. The departments with the highest Governance factor are San Andrés, La Guajira, Magdalena and Bolívar.
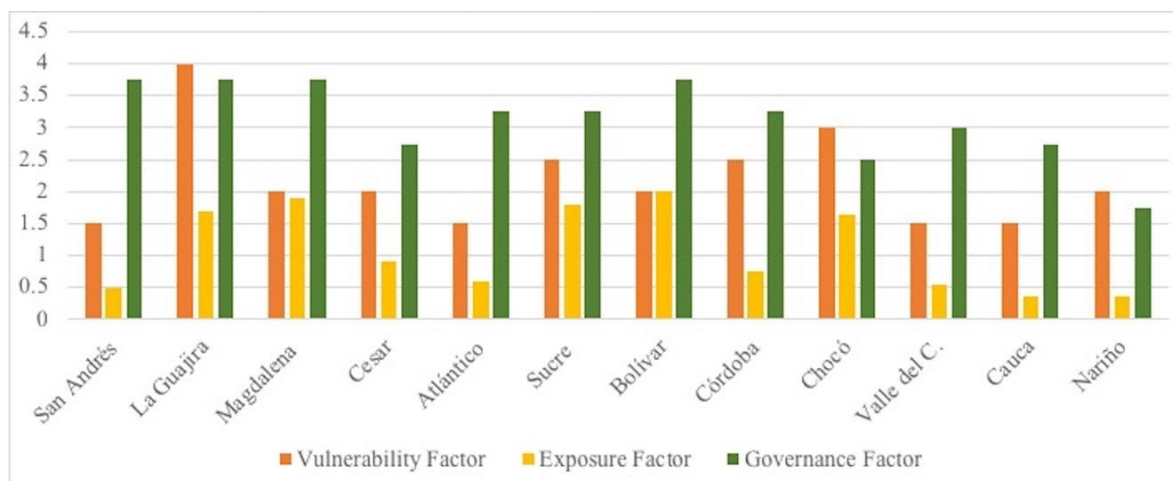
Figure 5. Weightings for the Vulnerability, Exposure and Governance Factors by Department.

The variable 'financial resources and existence of a financial protection account' has made a significant difference to the overall Governance factor. The four departments with the higher Governance score have made substantial progress in including financial protection in the departmental planning instruments and administrative structures so as to cope with disaster risk finance.

Remarkably, the departments in the Caribe region with the highest factors for Vulnerability and Exposure exhibit a high Governance factor. This fact is relevant since it serves to highlight the feasibility of an eventual formulation/implementation of a CRTM. The error ranges of the variables from the Governance factor according to Figure 3 are ±: h = 0.08, I = 0.07, j = 0.15, k = 0.04 and l = 0.02.

3.4 The Ranking of Departments under Future Climate

Eckstein *et al.* (2019; 2021) present the Climate Risk Index through an international ranking system. In this ranking system, Colombia has risen from 53rd (out of 181) in 2018 to 28th in 2019. All the Colombian departments demonstrate relevant changes in temperature and precipitation values. However, these changes will be more severe in certain regions in contrast to others, increasing or decreasing the CC risk levels. Below we present the ranking of territorial areas in terms of their suitability for implementing a CRTM with regard to future

CC scenarios. Table 4 shows the ranking of the departments adding new weightings to the initial factor score presented in Table 3.

The CC ranking indicates modifications to the previous rankings since the departments of Chocó and San Andrés both went up two positions. On the contrary, Magdalena dropped one place while Sucre dropped two. The most significant consequences in the Insular and Caribe region are related to the increase in droughts and consequent impacts on crops and livestock. The Pacífica region will witness an increase in flood events due to significant increases in precipitation (IDEAM 2017).

Table 4. Ranking of Departments in Terms of Suitability for Implementing a Climate Risk Transfer Mechanism with a Differential Approach: Differences between the Rankings under Current Climate and Future Climate Conditions (Number 1 (colored in red) indicates the most suitable).

No	Region	Department	Factor Score (Current climate)	Factor Score (Future climate)
1	Caribe	La Guajira	9.45	9.95
2	Caribe	Bolívar	7.75	8.75
3	Pacífica	Chocó	7.15	8.65
4	Caribe	Magdalena	7.65	8.15
5	Insular	San Andrés-Providencia-Santa Catalina	5.75	7.75
6	Caribe	Sucre	7.55	7.55
7	Caribe	Córdoba	6.5	7.5
8	Caribe	Atlántico	5.36	6.86
9	Pacífica	Valle del Cauca	5.05	6.05
10	Caribe	Cesar	5.65	5.65
11	Pacífica	Cauca	4.85	5.35
12	Pacífica	Nariño	4.1	4.1

4. CONCLUSIONS

Factors of Vulnerability, Exposure and Governance facilitate a broad consideration of the variables in exploring the suitability of a territory for implementing a CRTM. These factors bring together the features of the differential risk transfer approach and promote the inclusion of social components in the design and implementation of CRTM.

The variables included in the Vulnerability factor are pertinent when considering gender and ethnic issues in conjunction with the social/economic features of regions since they represent an official/open-access resource for quantitative analysis of study areas. The indicators considered in the Vulnerability factor are comparative indicators that relate the features of a specific department to those of others, thus facilitating a prioritization process.

The defining of variables through the three multisectoral workshops served to promote deliberation concerning the territorial components making prioritization both inclusive and viable. The multisectoral approach made possible a balancing out of the interests and expertise of each stakeholder, the topics relating to vulnerability, exposure and governance and the regions being analyzed.

The analysis of their vulnerability and exposure showed that the regions under scrutiny present special conditions compared to the other Colombian regions. Hence, it was felt appropriate to create a 'new region' comprising the 12 studied departments, obtaining the median as a reference when stating ranks through the weighting process.

The Caribe region, with 80% of its departments at the top of the rankings (without CC conditions), was strongly influenced by the Vulnerability factor. The Exposure factor impacted significantly on the Caribe region since it has been affected by floods, droughts and tropical cyclones. The variable 'financial resources and existence of a financial protection account' made a significant difference to the overall Governance factor. The four departments with the higher Governance score also revealed relevant signs of progress in including financial protection in their planning instruments and administrative structures. This may imply that good governance is a fundamental element for advancing disaster risk finance at the subnational level.

The CC ranking system indicated modifications to the previous rankings since the departments of Chocó and San Andrés went up two positions. This was because both departments showed an intensification of climate-related impacts, an increase in levels of vulnerability to climate-related disasters and poor adaptive capacity (covering the period 2011-2040 and under the scenario RCP 6.0). As such, future climate-risk was high for Chocó and very high for San Andrés. This consideration highlights the need for focusing resources on climate DRM through planning instruments/public policies (prospective interventions). We would recommend including the incidence of rises in sea levels in the Exposure factor in future analysis since the IDEAM's CC risk scenario does not consider state-of-the-art inputs as developed by Climate Central (2019).

The limitations of this study pertain to the non-inclusion of community members in the multisectoral workshops for prioritizing the variables and weightings. This relevant restriction in the methodology design and implementation was due to time limitations for establishing the criteria for selecting community representatives and then coordinating and carrying out the workshops. Hence, future implementations of this methodology should include the involvement of civil society organizations in the multisectoral agreement on

variables and factors. For the future implementation of this methodology and in accordance with data availability and technical capacities, we recommend: (i) The insertion of the variable of financial inclusion - with emphasis on women's financial inclusion - as a way to gain a better understanding of the level of financial vulnerability of the population; (ii) a sensitivity analysis related to the absence of input from the communities establishing the variables through a multiplier factor rather than an additive.

One of the main problems detected in our literature review was the need for better prioritizing territorial areas for CRTM. This implies inclusive approaches specifically through gender and ethnicity. Although highly challenging due to the inclusion of a wide range of social variables, the design and implementation of this methodology has resulted in satisfactory outcomes for several reasons, principally: The use of multisectoral workshops in demonstrating their suitability for the weighting of variables, as well as the accessibility to the proposed data sources which makes the methodology easily replicable and adaptable to different contexts.

The DRT approach is suitable for practical applications, as displayed in this research. The data (disaster datasets and institutional capabilities) and indicators are open information, freely available in developed and least developed countries alike. As such, this methodology has demonstrated itself to be flexible and adaptable, user-friendly in different contexts worldwide and with the capacity to benefit a wide range of actors.

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