

# Collaborative Landslide Risk Management in Rio de Janeiro



## **ENVIRONMENTAL- AND INFRASTRUCTURE PLANNING MASTER THESIS**

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## Abstract

The mountainous region in RJ is naturally prone to landslides, due to heavy rainfall and steep relief, but the risk has increased simultaneously with urban expansion. Many hillsides are occupied by informal settlements, or 'favelas', which provide many important services for the city, such as cheap labor. These favelas were subject to one of the most devastating landslide events that struck the region in 2011. Landslide risk management in Rio de Janeiro has taken a collaborative turn after acknowledging that previous strategies were ineffective. This research examines this collaborative turn through the lens of post-contingency theory, to evaluate the performance and collaboration of the biggest landslide risk management programs of the city of Rio de Janeiro. The aim of the research is to fill the knowledge gap on the possibilities that the favelas can offer for landslide risk management to increase its equity and effectiveness.

### Key words:

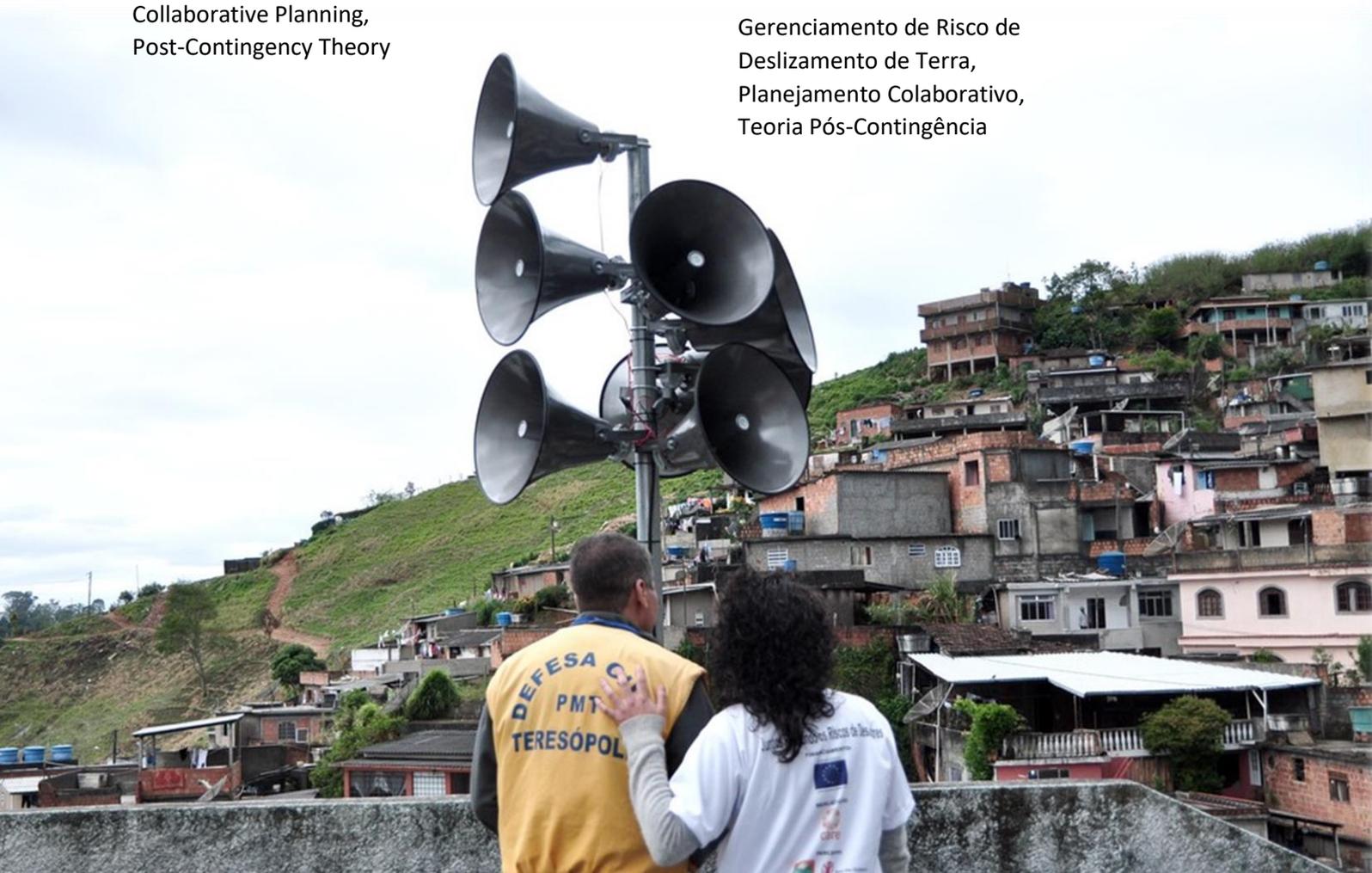
Landslide Risk Management,  
Collaborative Planning,  
Post-Contingency Theory

## Resumo

A região montanhosa do RJ é naturalmente propensa a deslizamentos de terra, devido às fortes chuvas e relevo acentuado, mas o risco tem aumentado simultaneamente com a expansão urbana. Muitas encostas são ocupadas por assentamentos informais, ou "favelas", que fornecem muitos serviços importantes para a cidade, como mão de obra barata. Essas favelas foram sujeitas a um dos eventos de deslizamento mais devastadores que atingiu a região em 2011. A gestão de riscos de deslizamentos no Rio de Janeiro deu uma guinada colaborativa após reconhecer que as estratégias anteriores eram ineficazes. Esta pesquisa examina essa virada colaborativa por meio de uma abordagem de planejamento pós-contingência, para avaliar o desempenho e a colaboração dos maiores programas de gestão de risco de deslizamento da cidade do Rio de Janeiro. O objetivo da pesquisa é preencher a lacuna de conhecimento sobre as possibilidades que as favelas podem oferecer para a gestão do risco de deslizamentos para aumentar sua equidade e eficácia.

### Palavras-chave:

Gerenciamento de Risco de  
Deslizamento de Terra,  
Planejamento Colaborativo,  
Teoria Pós-Contingência



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# Introduction

This research examines the recent evolution of landslide risk management (henceforth: LRM) in Rio de Janeiro (henceforth: RJ), which started in response to a great landslide disaster that took the lives of 900 people throughout the state and displaced many more (Ardaya et al., 2017). The event illustrated that landslide risk was increasing because of climate change (Debortoli et al., 2017) and urbanization (Hardoy & Pandiella, 2009), and that renewal of LRM was needed. It meant the start of a transition within landslide risk management away from the technocratic approach towards a more collaborative one (Frank et al., 2019).

The mountainous region in RJ is naturally prone to landslides, due to heavy rainfall and steep relief, but the risk has increased simultaneously with urban expansion (Royle & Smyth, 2000). Many hillsides are occupied by informal settlements, or 'favelas', forming the peri-urban area of RJ. Although the peri-urban area is mostly informal in RJ, it provides many important services for the city, such as cheap labor. However, urban planning continues to criminalize and condemn their self-organization as a danger to the city. What is even more wicked, is that urban planning is responsible for the existence of the informal in the first place, by excluding the lower income groups from spatial plans (Yiftachel, 2009). The neighborhoods are completely self-constructed, as urban planners failed to provide housing for the lower income groups when they immigrated in masses to the city during times of rapid industrialization (Holston, 2009). Many of the new migrants arrived from the Northeast, without experiences and knowledge of landslides, and therefore settled on the hillsides while clearing the vegetation (Hardoy & Pandiella, 2009). This lack of knowledge of local risk and of safer practices has led to the increase in landslide risk and marginalization of these neighborhoods, with authorities providing no or insufficient public services. However, as the peri-urban in RJ is one of the most sophisticated self-organized urban systems in the world, they have managed to create many services themselves. Except for their dwellings, the residents have taken on the provision of networks of water and electricity, a variety of public services and even a self-sustaining job market.

Although the communities have proven to be able to take up very difficult tasks, LRM might be the most difficult one due to its diverse and technical nature, and is furthermore often too little of a priority for them (Ardaya et al., 2017). Governmental action exists of structural measures, mainly building retention walls and channeling rivers. Although these measures are expensive, they do not address the root causes of environmental degradation and improper land use, and can therefore not be considered sustainable long-term prevention and mitigation strategies (Schelchen et al., 2017). Moreover, landslides continue to overwhelm these structures that are designed to contain them (Coates, 2019). The most popular intervention, the containment wall, stabilizes the slope and captures debris that comes down after heavy rainfall. However, because the measure is expensive, it is only implemented in the rich areas. This approach therefore increases inequality in risk distribution, and neglects the already most vulnerable informal settlements (Sandholz et al. 2018).

New collaborative practices have come to exist in recent years, which are partly undertaken by the communities. This thesis analyzes some of these innovative practices, to assess if there is an improvement in equity and effectiveness. The research looks into the possibility of improving landslide risk management in RJ, by investigating the role that the community can fill in. There are different roles possible, and this thesis investigates three of these already existing roles for the community. They consist of: 1. a reforestation program where the community is employed by the government; 2. a community civil defense program that has a main goal of capacity-building to ensure quick disaster response; and a landslide alert and evacuation program, based mainly on existing community infrastructure and capacities. Evaluation of these three projects makes it possible to determine comparative advantages of the different programs, and make recommendations on how these landslide risk reduction programs could possibly be improved.

This research adds to the field of collaborative planning and landslide risk management. The academic relevance of this research is to investigate the relevance of post-contingency theory, which touches upon the debate when centralized and decentralized forms of governance are more appropriate, for CLRM in RJ. The theory, however, is developed for and applied to decentralization within the government, and not yet to public participation. This research fills this knowledge gap, by testing the theory on its relevance for state-community collaboration. The societal relevance of this research is to examine the possibilities that the favelas offer for landslide risk management. Does collaboration increase the equity and effectiveness of landslide risk management in RJ, or does it lead to inequality and ineffectiveness because of unproper application or bad intentions (Davoudi, 2012; Kaika, 2017)? Results of the comparative case study are valuable for other marginalized communities that suffer from environmental disasters. Conclusions and recommendations should be taken into account, not replicated, for similar problems in different contexts (Mukhtarov, 2014).

### **Primary research question**

Can compatibility of strategical function and governance structure help explain (un)successful performance of collaborative landslides risk management in RJ?

### **Secondary research questions**

- How compatible are the governance structure and strategical function of the programs according to post-contingency theory?
- Do patterns exist across cases regarding the performance and the compatibility of function and structure of the different CLRM programs?
- Can lessons be derived from post-contingency theory to improve CLRM policies in RJ?

# Theoretical framework

The first section of this chapter will give more information on the practical background in which this research is situated. Then, in the second section, there is made a link between the practice and planning theory, when post-contingency theory is introduced. The changes that are currently happening in CLRM in RJ can be defined and analyzed with this framework that looks specifically at the debate in planning practice between centralization and decentralization. This approach is used because it does not only typify collaborative planning, but also gives a reasoning for when which type is appropriate. The two most important constituents of the theory are function (the *what*) and structure (the *how*). These two constituents are explained in detail in the third section of the chapter.

## 2.1 Integrative turn in landslide risk management of RJ

The main focus in landslide risk management has historically been on reactive policies to protect and clean up, inspired by central command and aimed for damage control (Frank et al., 2019). Structural measures have been used to reach this goal, because of the visibility of the structures and the familiarity with the planning process (Ardaya et al., 2017). There are several types of structures, including hillside stabilization works and flood controls, but most common is the containment wall. Although it is indeed important to make sure that current measures are up to date, or in the words of Duitz & Galaz (2008), to exploit existing strategies, it is just as important to explore new strategies, because this spreads the risk and strengthens the conventional strategy. The containment walls are designed to capture debris that comes down before it reaches a community, however, landslides continue to overwhelm the structures designed to contain them, resulting in recurring material damage and fatalities (Coates, 2019; Schelchen et al., 2017).

Meanwhile, non-structural measures are barely considered by the responsible parties in RJ. The main objective in the Climate Change Adaptation Strategy for example, remains on advancing technical-scientific knowledge on structural measures, geotechnical assessments, and meteorological monitoring (Municipality of RJ, 2016b). But when preventive non-structural measures are used, it is not in favor of informal settlements. The majority of these measures entail removing neighborhoods in areas where structural measures are not deemed cost-effective, which are usually slum areas that are in high risk or that are threatening areas of native vegetation (Ardaya et al., 2017). Although removing settlements decreases landslide risk, both in ways of vulnerability and probability, evicting residents has an enormous impact on their livelihoods. Social housing projects are located in the periphery, and relocation therefore results in a spatial mismatch of poor growth of the periphery (Barandier Jr. et al., 2010). The existence of favelas and landslides are closely related, as it was the only place close to the center which was not occupied due to the high risk of natural disasters. Favela dwellers have initially accepted this risk, in order to have more job opportunities. Relocation thus has an adverse effect on economic opportunities, and personal and cultural relations. Therefore, most residents have expressed that they prefer to avoid relocation at all cost (Ardaya et al, 2017).

In 2011 extreme weather conditions triggered several landslides throughout the whole Serra region, a mountain range across the whole state of Rio de Janeiro. With 1000 casualties reported, but twice as many still missing, it is the most severe natural disaster in the history of the country (Ardaya et al., 2017; Coates, 2019). The loss of life, misplacement of households and financial damage was of extreme proportion, and a wakeup call for the government. The event made the government realize that disaster risk management was inadequate, and they had to improve the management of the risk of landslides.

Scholars indicate that LRM had reached an ‘suboptimal stable equilibrium’ (Duit & Galaz , 2008). Technical protection measures were still overtopped throughout the region, meaning this strategy is ineffective, without complementary strategies. Only by combination of exploiting existing strategies and exploring new ones LRM can be improved (Ardaya et al., 2017; Sandholz et al., 2018). The authorities decided to move away from the top-down technocratic approach. This meant a shift in focus from the symptoms of the problem, towards the root causes of the problem, and with this shift other domains became relevant to LRM, including spatial planning, water management and environmental management. When one single problem leads to many developments in different domains, there can be spoken of a ‘transition’ (Loorbach & Rotmans, 2005). There is now a variety of actors involved in managing the landslides in RJ. The actors involved in 2018 can be seen in table 1.

<b>Actor</b>	<b>Function/responsibility</b>	<b>Usual action/measures in case of informal settlements at risk from landslides</b>
Defesa Civil Municipal (Civil Defense of the municipality)	Plan and coordinate action to reduce disasters in the municipality	Civil defense, focus on civil society activities, e.g. support of early warning and escape route systems, community-based preparedness, emergency response, rescue
Geo-Rio - Fundação Instituto de Geotécnica do Rio de Janeiro (Foundation Institute for Geotechnics)	Municipal authority to monitor & stabilize slopes and take necessary measures, risk mapping	Lowering of risk level by means of engineered constructions like concrete walls, drainage, etc.
Rio-Águas - Fundação Instituto das Águas do Município do Rio de Janeiro (Foundation Institute for Waters)	Municipal water authority, responsible for management of rain water, flood prevention and sanitation in the West Zone	Flood and mudslide risk reduction
SMAC - Secretaria Municipal de Meio Ambiente e Conservação (Municipal Secretariat for Environment and Conservation)	Municipal environmental agency, responsible for conservation, municipal protected areas and park/garden management, environmental education reforestation and taxation	Reforestation of degraded hills to reduce landslide risk, maintenance of reforested parts, plantation activities in different succession steps, usually involving local communities in plantation and maintenance activities
SMH - Secretaria Municipal de Habitação (Municipal Secretariat for Environment)	Municipal housing authority	Potential relocation of buildings or communities at risk
SMU-Secretaria Municipal de Urbanismo (Municipal Secretariat of Urbanism)	Municipal planning authority, responsible for urban planning, policies, land use planning and monitoring	Spatial planning and zoning
COR - Centro de Operações (Center of Operations)	Operations and command center	Data collection and provision
Academia	No formal responsibilities, potential advisors to authorities	-
Favela associations	Lead of local communities, contact persons for municipal authorities	Involved actors in activities like early warning, awareness campaigns, trainings and reforestation

*Tabel 1 - Main actors and responsibilities related to landslides in informal settlements in 2015 (Sandholz et al., 2018)*

The responsibilities in the table can all be placed under one of the strategies of the disaster risk rose. The disaster risk rose is at the basis of the Sendai framework of the UN, which sets out the different strategies that can be focused on in disaster risk reduction (henceforth: DRR): prevention, mitigation, preparedness, response and recovery (UN office for DRR, 2020). The disaster risk rose is adopted by DRR organizations all over the world, including the Civil Defense in RJ. Their interpretation is visualized in Figure 1. The disaster risk rose is no blue print, as every context needs a different strategic focus, but there should always be a good balance between these strategies (Jorissen, R., Class Lecture, March 9, 2020). In RJ the focus between strategies is currently unbalanced, as mitigation receives by far the most attention. The UN has stated that what is necessary is “a change of mindset and moving from reaction to prevention” but that at the same time “prevention is not the first thing that politicians want to invest in. If you are successful in prevention you cannot necessarily prove it and politicians want to be able to prove things” (UN office for DRR, 2020). This short-term thinking is also present in Rio. Whereas the politicians can showcase their big containment walls, the strategies of prevention and preparedness have less visible and promotable benefits for politicians to be reelected (Sandholz et al., 2018).



Figure 1 – LRM strategies: prevention, mitigation, preparedness, response and recovery (Civil Defense of RJ, 2017).

The integration of strategies is also mentioned in the Resilience Strategy of the City of Rio de Janeiro (Municipality of RJ, 2016a), and explicitly in their goal to “Mobilize Rio to be prepared to respond to extreme weather events and other shocks”. The report confirms that the municipality is aware that it is necessary to adopt other strategies like prevention and preparedness instead of only relying on mitigation in the form of technical measures. The report furthermore mentions to expand participation, through their program Resilient Communities, which “increases social cohesion in and between communities; empowers citizens; fosters a culture of prevention and preparation” (p. 53). LRM is an incredibly complex matter, but for long RJ has approached it as if structural mitigation measures would solve it all. However, new configurations have come to exist in RJ since 2011, which are participatory prevention, preparedness and response programs. The aim of the research is to find out if they are successful configurations; if their structure and function match well; and then to compare the configurations to each other and find out if there are comparative advantages between them and why. This thesis will focus on the collaborative practices in landslide risk management that have come to exist in RJ since 2011. What this collaborative turn in LRM looks like when applying the post-contingency planning framework can be seen in Figure 3:

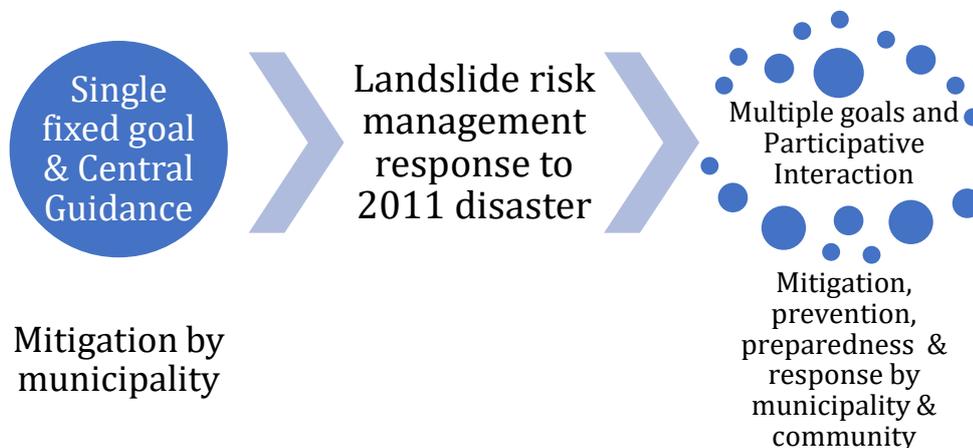


Figure 2 – Integrative turn in LRM in RJ in response to 2011 disaster

## 2.2 A Post-Contingency Approach

To comprehend the inclusive and integrative turn of LRM in RJ, this thesis makes use of a theoretical framework derived from post-contingency planning theory, as explained by Zuidema (2016). A contingency approach on governance accepts that the performance of organizational structures and strategies is contingent on the contextual circumstances encountered. Function and structure are combined in a configuration, but some configurations match better than others for a specific context. In broad terms, simple contexts require a technical rationale, an approach with central guidance and a single fixed goal. However, the more complex the context, the more participative the form of governance should be to reach multiple composite goals. The post-contingency approach is an alteration of contingency planning. It does not suggest that complexity determines the approach that is needed, but that it merely helps to “translate judgements about desirable and undesirable consequences into limiting the range of eligible planning approaches” (Zuidema, 2016, p. 86).

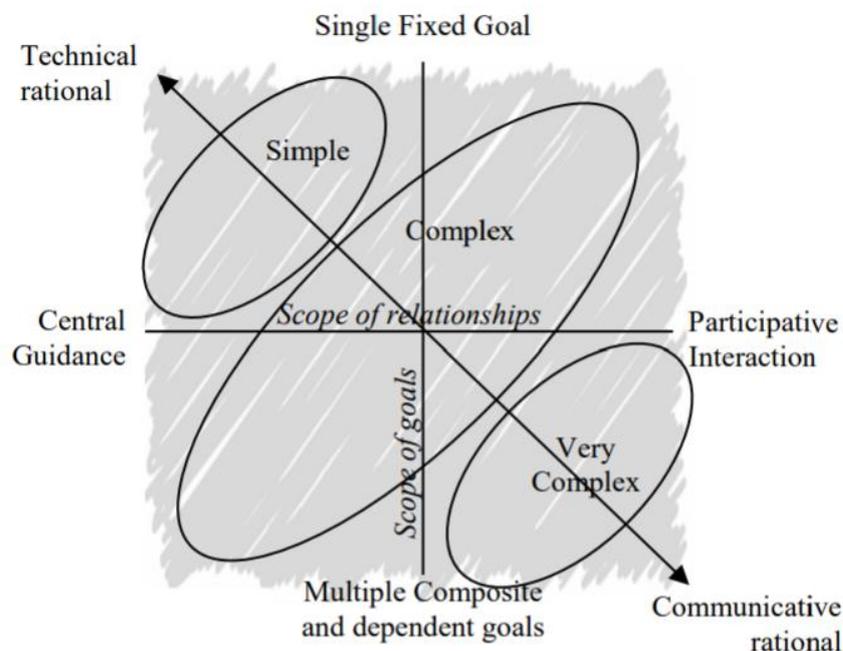


Figure 3 - Framework for post-contingency planning along the scope of goals and relationships (Zuidema, 2016)

Zuidema explains that the function can be seen as what is to be achieved (objectives), and the structure as how this is achieved; who is involved in the decision-making and implementation. The function for this research is based on the DRR strategies that are used by the Civil Defense of RJ and inspired by the Sendai framework of the UN (UN office for DRR, 2020). The research looks into programs with these strategies as their main aim. The Sendai framework recommends a diverse approach towards DRR, as there is global historical emphasis on protection. For implementation of these new strategies, there exist several institutional structures. The structures used in this research are adopted from the guidebook on community landslide risk management of the World Bank (Anderson & Holcombe, 2013) with different structures expressing different levels of participation.

According to contingency-planning, the more complex the issue, the more diverse and inclusive management should be: “*given a particular function there are only a limited number of suitable structures and vice versa*” (Miller, 1996, as cited in Zuidema, 2016). But along the lines of its successor, post-contingency planning, the choice for a particular type of function or structure is not only based on objective-oriented circumstances, but furthermore on inter-subjective-oriented

norms, values and judgements. There can be chosen for flexibility, with multiple goals of multiple actors, or for certainty, with generic regulations by central guidance: *“A routine function, for example, produces more stable and formal structures, whilst stable and formal structures often reduce the possibility for innovative functions. Certain configurations therefore make for more stability and certainty, while flexible configurations allow for more innovation”* (Zuidema, 2016, p.99).

The difference with classical contingency approaches, is that governance form is now seen as a choice based on which consequences are desired. Although contingency theory was critical at technical-rationale and its ‘best practices’ and ‘one size fits all approaches’, the theory remains deterministic in relation to function and structure. Other scholars too have been critical to this and conceptualized this relation as a more dynamic one. Gresov & Drazin, for example, stated in 1997 already: *“functional requirements do not determine a particular social structure, but rather permit a range of structures that will fulfil the functions required”* (as cited in Zuidema, 2016). Although this approach is a critical response and correction to ‘best practices’, Zuidema does claim that there exist ‘ideal governance approaches’. This entails that there is not one best practice, but there does exist a range of better practices. From a communicative rationale perspective, this could still seem too deterministic and leaning towards the classical approaches, like a move from a monopoly towards an oligopoly of best governance approaches. But post-contingency approach tries to find middle ground between a technocratic and a communicative rational. Different contexts allow for a range of choices, which should be based on the desired objectives. This is in essence the main function of the post-contingency framework; to inform this choice, so as to make decisionmakers aware of the range of possibilities that exist and the consequences of each one of them.

A point of criticism of Oliveira (2017) addresses this function of the framework. He questions the philosophical nature on which post-contingency is based, as decisionmakers which it is aimed at are more practically minded. Instead of navigating the many forms of governance along that theory, they probably prefer to adopt governance forms that have proven effective in similar settings, or that are in line with current governance trends. Zuidema (2016) and Oliveira (2017) agree that more empirical research is necessary to convince not only the academic world, but also planners and decisionmakers in practice. This research aims to do just that, to explore the relevance of post-contingency for the practice of CLRM in RJ and hopefully to inform local leaders on making choices between different approaches based on what consequences they deem necessary.

## 2.3 Configurations of Function and Structure

Not just the strategies of the RJ government are shifting, the role of the government is also shifting (Frank et al., 2019). Traditionally, LRM in RJ has worked with strong government, with hierarchical steering. However, implementation of strategies can be done by a wider variety of actors than just the government. This is called governance, which is based on ‘self-organizing’; a society that selects their own means and goals (Zuidema, 2016). A strong government and strong governance have their comparative advantages. Problems of high complexity require tailor-made solutions, which is more easily done by lower level of governance as it is closer to the specific context. Decentralization furthermore increases the possibility to focus on different strategies, so in the case of LRM it could become easier to diversify disaster risk strategies. Centralized climate action also has its benefits: a greater capacity to meet single fixed goals, stronger regulation, which makes it easier to safeguard minimal levels of protection against unsustainable land development, and economies of scale, greater number of staff, and more specialized knowledge on LRM (Zuidema, 2016). A hybrid of governance types, could combine strong and robust regulation (central benefits) with flexible and tailor-made approaches (decentral benefits). However, there are so many different structural and functional options, that it is impossible to speculate about the many possible combinations.

What can be looked at, are the common approaches that emerged because they performed well. When moving away from a strong government, two compensatory actions have to be taken: the loss of the economy of scale (resources & expertise) should be corrected for, and the restraints on the ability and willingness of the community should be removed as much as possible. In other words: “*decentralization should be confined to tasks that require skills and resources which local units should, realistically, be able to acquire*” (Zuidema, 2016, p. 40). How much of a transition from strong government to governance is possible, depends on the local capacities and the degree of complexity of the problem. So, when changing from a top-down to a collaborative structure, function should contingently change along the spectrum from ‘single fixed goal’ to ‘multiple composite goals’. If this does not happen, there can be a mismatch of function and structure. Decision-makers will have to choose between approaches based on the comparative advantages.

The Community Landslide Risk Management report of the World Bank is an extensive manual for governments, experts or NGO’s on how to help communities reduce the risk of landslides (Anderson & Holcombe, 2013). The authors suggest three common collaborative approaches between government and society for LRM. These approaches differ in degree of participation, and the authors state that choosing between the different arrangements should be based on finding an appropriate balance between community knowledge and expert knowledge; project scope and community perceptions of risk; and policy constraints and community decision-making powers. The framework is adopted from the typology of interests in participation by White (1996). Cornwall (2008) explains these interests for managers and participants in more detail which can be seen in Tabel 2.

*Tabel 2 - Interest of participation of communities in collaborative management (Cornwall, 2008)*

Form	What 'participation' means to the implementing agency	What 'participation' means for those on the receiving end	What 'participation' is for
Nominal	Legitimation – to show they are doing something	Inclusion – to retain some access to potential benefits	Display
Instrumental	Efficiency – to limit funders' input, draw on community contributions and make projects more cost-effective	Cost – of time spent on project-related labour and other activities	As a means to achieving cost-effectiveness and local facilities
Representative	Sustainability – to avoid creating dependency	Leverage – to influence the shape the project takes and its management	To give people a voice in determining their own development
Transformative	Empowerment – to enable people to make their own decisions, work out what to do and take action	Empowerment – to be able to decide and act for themselves	Both as a means and an end, a continuing dynamic

Cornwall (2008) explains that this typology of participation offers insights on the different interests in various forms of participation. It could thus also be used to identify conflicting ideas between the government and the community. She states that careful reading of the typology is required. A normative way of looking could imply that there is a progression towards more ‘genuine’ forms of participation. However, instrumental participation can be very beneficial to a community that has little experience with engagement before. On the other hand, when transformative participation becomes nothing more than a ‘do-it-yourself’ approach, there could be resistance instead of enthusiasm among the participating community. Participatory development theory claims however, in agreement with post-contingency planning, that “different uses of participation are not exclusive, but sit along a continuum. It means that in any given situation we need to be realistic and specific about the nature of participation that is ... possible” (Mohan, 2007, p. 82). The continuum mentioned here refers to the same spectrum as shown in Figure 2. In the following sections, the collaborative LRM approaches of the World Bank are explained (Anderson & Holcombe, 2013).

### 2.3.1 Instrumental approaches

Instrumental approaches regard community participation as a means of achieving project objectives, which entails that building community capacity is not an objective in itself. Also referred to as ‘activity-specific’ participation, the reason to involve the beneficiaries of projects is to increase efficiency and effectiveness, not to fight the exclusion of social groups and classes (Mohan, 2007). Participation has been absent in LRM until 2011, while in other governmental sectors, like the departments of water and environmental management, participation has existed for a long time already (Municipality RJ, 2017). Cornwall states that especially in cases where participation has not played a big part before, instrumental forms of participation can be of great importance: *“even the most nominal forms of participation can give citizens a foot in the door if there has been no constructive engagement with them before”* (2008, p. 273). She argues that there is no normative hierarchy in participation forms. However, other scholars have a more critical standpoint towards ‘nominal’ forms of community management, as it can fail to address social inequity and sustainability, when the main aim is transferability and the realization of repeatable outcomes, rather than accommodating the needs of local people (Dressler et al., 2010).

### 2.3.2 Collaborative approaches

Collaborative approaches are based on exchange of resources throughout the project cycle in order to achieve a shared objective. The main difference with instrumental approaches is mutual learning; the knowledge of participants on the local context is regarded key in setting the project objectives (Cornwall, 2008). Except for achieving a shared objective, this approach aims to increase awareness and build capacity of the community. This is due to the newly formed working relations and experiencing the project process, but more concretely through intensive training programs that the local community undergoes to learn more about natural disaster prevention (Catalytic Communities, 2019). This institutional arrangement is often used to ensure sustainability and leverage, as it allows the participants to have an active part by having an influence in shaping and managing the project (White, 1996). This approach is also referred to as ‘representative’ because community interests are often reflected in the program’s objectives when this governance structure is applied.

### 2.3.3 Supportive approaches

Supportive approaches recognize existing or potential capacity within a community—the government or agency provides technical, financial or material support for the community to initiate and undertake its own project (Cornwall, . This approach can be translated to self-organized landslide risk management, taking full advantage of the capacities of the informal settlements. This institutional structure can be seen as a transformation of social relations, as communities become responsible for former governmental tasks (Mohan, 2007). Restemeyer et al. (2015) state that this approach is characterized by a change in behavior and mindsets, but mostly by a transfer of responsibility. Davoudi (2012) mentions a great danger in this form of ‘participation’, as the burdens of climate change adaptation can be shifted upon vulnerable communities. He furthermore claims that this cannot only be a by-effect, but that it could even be the very reason that governments promote this form of engagement. White states that his form of participation *“is therefore at one and the same time a means to empowerment and an end in itself, so breaking down the division between means and ends which characterizes the other types (of participation)”* (1996, p. 147).

## 2.4 Conceptual Framework

The collaborative approaches of the World Bank are in line with the simple, complex and very complex areas in the post-contingency framework of Figure 2. Figure 4 shows these approaches as the range of configurations where “*structural characteristics can be expected to work well (match) given a certain set of functions to be performed*” (Zuidema, 2016, p.29). The figure thus illustrates the relation between post-contingency theory and CLRM. There are two prerequisites for configurations to be considered succesful. First of all, when their structure and function match, which entails that the programs can be placed under either the ‘instrumental’, collaborative’ or ‘supportive’ approaches. Second of all, if the approach is in line with the complexity of the context. The defining aspects for complexity are the need for certainty and the limits to willingness and ability of the community to take on the DRR tasks. Zuidema (2016) explains that “*If serious constraints cannot be realistically removed, important doubts arise as to whether decentralization should be pursued at all*” (p.44). When there is one clear task at hand, and there are many limits to the ability and willingness for communities to undertake DRR tasks, it makes more sense to opt for an ‘instrumental’ approach. But when there is already certainty to some extent, for example because of existing structural measures like containment walls, and there are some limits, there is room for a collaborative approach that can include capacity building and community objectives. With little to no limits, when the community is well-organized, there is room for a supportive approach where the community undertakes their own task with government support. The left-upper quarter in Figure 4 represents the ‘instrumental’ governance approach, appropriate with limited complexity, the bottom-right corner shows the ‘supportive’ governance approach for contexts of high complexity and in-between are the collaborative approaches, appropriate with intermediate complexity. The framework in figure 4 shows if there is high compatibility of function and structures when the programs fall within the circles, which can inform on the performance of CLRM programs (Goodrick, 2014).

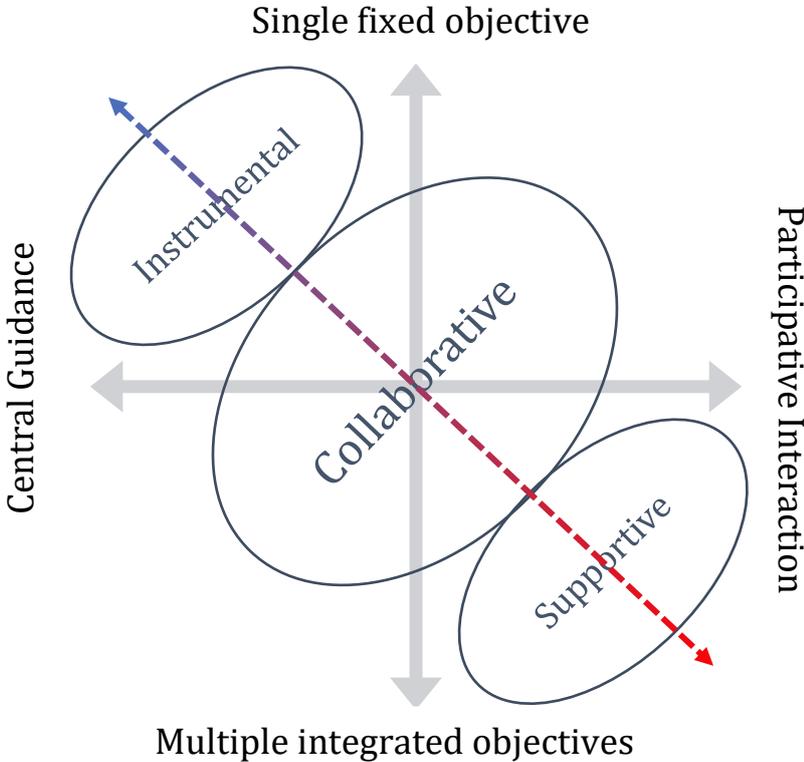


Figure 4 – Adoption of post-contingency framework (Zuidema, 2016) for the ‘ideal’ CLRM configurations (Anderson & Holcombe, 2013). The axes represent structure and function, and the arrow low (blue) to high (red) complexity.

Figure 5 represents the main conceptual framework of this thesis, distinguishing the three most important aspects of post-contingency planning: function, structure and complexity. The left branch of the theoretical framework relates to the function of the CLRM programs, represented by the objectives to be met. The right branch refers to the different types of participation structures. The integrative turn resulted in more participative and diverse LRM after the 2011 disaster. This research will assess if these innovative practices can be deemed ‘successful configurations’ according to post-contingency theory, and if high program performance is contingent with high compatibility.

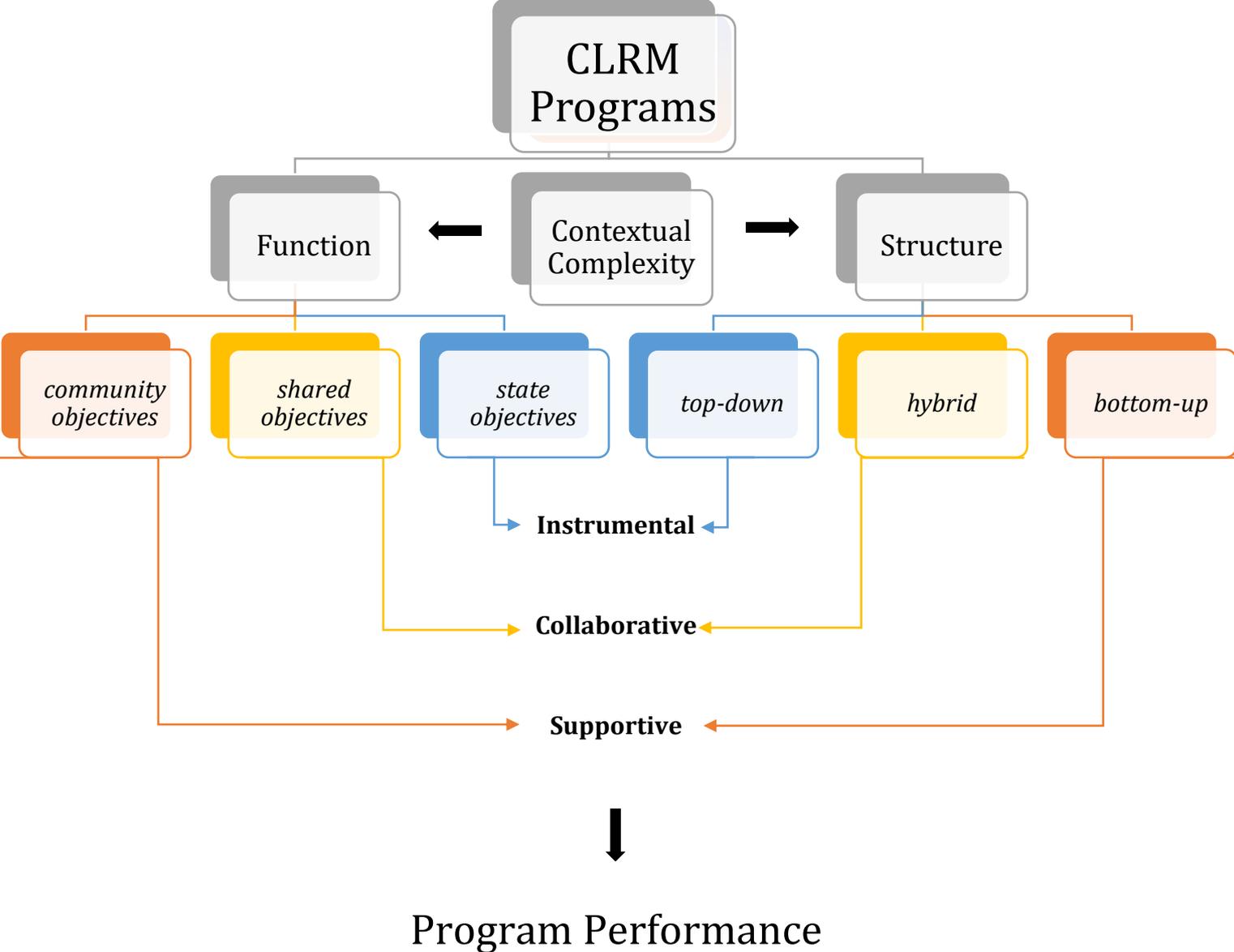


Figure 5 – Post-contingency conceptual framework for CLRM. Program performance is high when there is a ‘ideal’ configuration of function and structure, and when the configuration is appropriate according to the contextual complexity. Blue indicates the appropriate function and structure with low, yellow with medium, and red with high complexity.

# Data Collection Strategy

## 3.1 Comparative Case Study

This thesis uses a comparative case study to evaluate the impact and analyze the participation and objectives of various collaborative landslide risk management programs in RJ. The context is landslide risk management in RJ with a spatial boundary of the municipality of Rio de Janeiro. Because the context is the same for all programs, only a small number of cases is needed (Yin, 2014). The timeframe of the analysis is between 2011 and the present, as the landslide events of 2011 throughout the state of Rio de Janeiro initiated the integrative turn in landslide risk management. The deliberate choice for a comparative case study is made because it is the most suitable tool to analyze similarities, differences and patterns across multiple cases with shared goals. The logic of research design, which reveals the cause-and-effect relations, the underlying theory and possible insights for development of the project, is ‘theoretical replication’: each case is selected so that it “predicts contrasting results but for predictable reasons” (Yin, 2014, p. 49). The cases are three collaborative landslide risk management projects, which are selected based on their differing functional strategies. The aim is to identify if ‘successful’ configurations of function and structure according to post-contingency theory lead to effective performance, and if post-contingency theory can help establish recommendations for the current CLRM practices.

Approaches to data analysis, interpretation and reporting will thus be based not on generalization but on the production of context-dependent knowledge, which is more valuable than coming up with predictive theories and universals in the study of human affairs according to Flyvbjerg (2006). He argues that qualitative case study research is criticized as it is not possible to generalize on the basis of a single case. The author counters this criticism by saying that a critical case makes it possible to use falsification, which is the most rigorous test to which a proposition can be subjected: “if just one observation does not fit with the proposition, it is considered not valid generally and must therefore be either revised or rejected” (Flyvbjerg, 2006, p.228). It can thus be stated that the case study is useful for generating and testing hypotheses, however, it is not limited to these activities. Flyvbjerg argues that it is often not desirable to summarize and generalize case studies as the rich problematic will be lost by doing so. This is also the case for this research: with a narrow focus there is a danger of linking a program’s success to one combination of function and structure, and if other programs are not successful this combination would be labeled the ‘best practice’ of participation. However, all the case studies involve programs of different functions and in a different contexts, which makes it impossible to make conclusions about ‘successful’ configurations. Instead, Flyvbjerg states, good studies should be read in their entirety, which translates to the aim of thickening the narrative and creating a hard-to-summarize research that offers concrete context-dependent knowledge. For this research the choice is made to follow the views of Flyvbjerg by generating such context-specific knowledge for CLRM in Rio de Janeiro.

This method is not the only one that has been looked at for this research, as Qualitative Comparative Analysis has also been considered. This method can provide more representativity, but less in-depth knowledge for comparative case studies. It is not claimed that this method is inferior to the current method, but there were not enough CLRM programs of a large size in the same context, and a large *N* is deemed necessary for comparison with this method. The author preferred to gather highly context-dependent knowledge as it is believed that this will make it possible to provide valuable recommendations to improve the actual planning practice of CLRM in RJ, besides the main objective of testing the theory of the post-contingency approach in that context.

Yin (2014) explains that there are different data collection levels related to the different phases in the multiple-case study procedure, as can be seen in Figure 6. The first level of data collection exists of an analysis of the program functions, structures and performance *within* programs, the data collection question on the next level entails a comparison of compatibility of function and structure *between* programs. These two comparisons are at the heart of the comparative approach (Goodrick, 2014) but are only the lowest levels of the whole study.

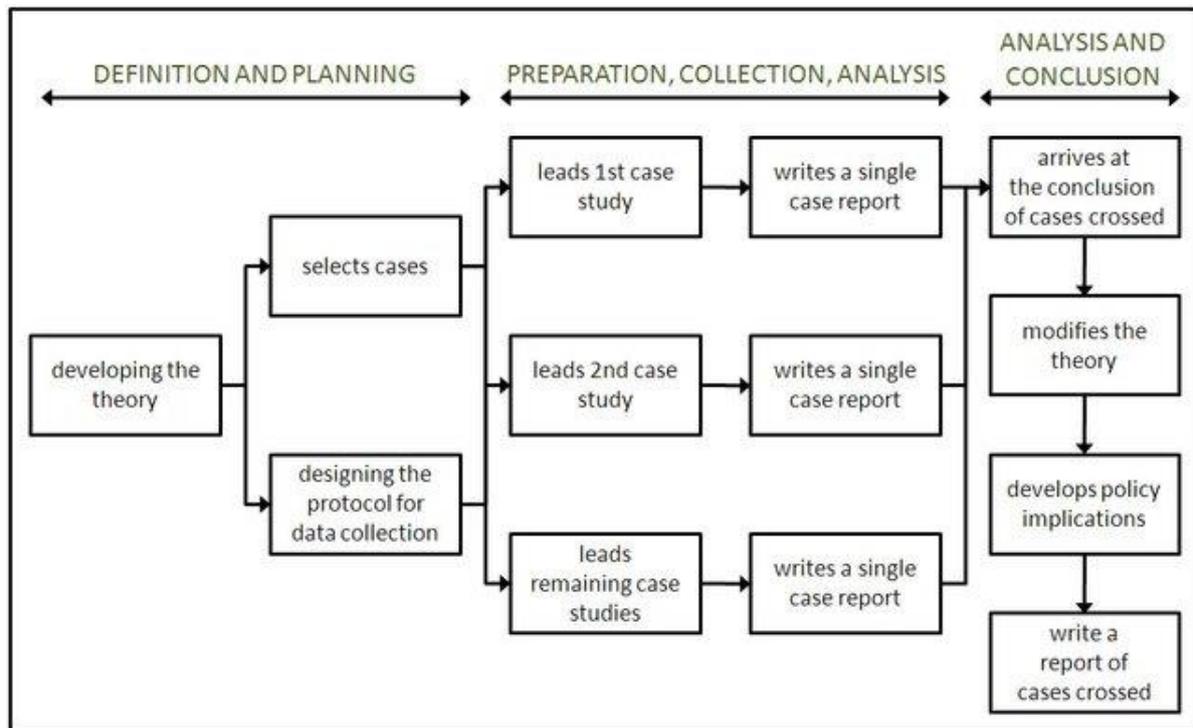


Figure 6 - Cross-case study procedure (Yin, 2014)

These data collection levels are related to the research questions of this thesis, which can be seen in Figure 7. Yin explains that when conducting a multiple-case study, it is essential to collect data for the separate case studies and write individual reports, without making interlinkages at first. The function and structure analyses, for example, only answer the first levels of data collection questions. So when conducting interviews for a single case study, it is important to keep in mind the Level 2 questions, but not ask them directly to the interviewee. Only after writing the individual case reports the level 3 questions will be examined. The question at Levels 4 is about the entire case study and beyond, and is of interest when final conclusions are drawn. The first partial research question “How compatible are the governance structure and functional strategy of the CLRM programs?” relates to the individual case, and is thus a Level 2 question. “Do patterns exist across cases for the relation between compatibility and impacts of the different CLRM programs?” relates to cross-case conclusions, and is thus a level 3 question. For this pattern matching will be key (Goodrick, 2014). “Can lessons be derived from post-contingency theory to improve CLRM policies in RJ?” relates to a question of the entire study, and is thus a Level 4 research question. Only when this question is answered, recommendations can be formulated that will inform the main research question: “Can compatibility of strategical function and governance structure help explain (un)successful performance of collaborative landslides risk management in RJ?”

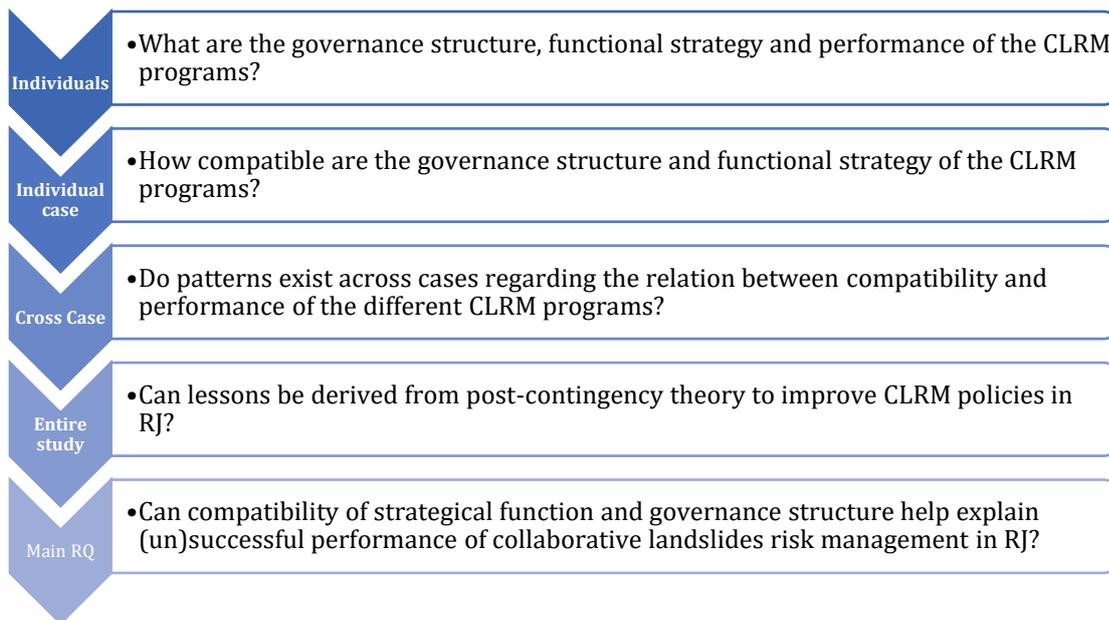


Figure 7 - Research question levels

The data collection techniques exist of several methods in order to ensure data triangulation. The theoretical framework has been created on basis of literature study and previous studies. Methods that will be used for the data collection are archival records (documented objectives, survey data, policy reports) and semi-structured interviews (with government staff, community participants and experts). Semi-structured interviews exist of predetermined but open-ended questions, which allow for more control over the topics of discussion than unstructured interviews, but also allow for a guided conversation instead of a fixed range of responses, which is the case with a fully structured interview. The semi-structured interview is especially useful for typological analysis as is the case of this research (Ayres, 2008). It is important to prepare some follow up questions that work as ‘probes’ (Ayres, 2008). By means of active listening, a neutral probe can be helpful to elicit more information when the interviewee shares an important insight. For example, the question: “Has vulnerability of the community towards landslides changed after the project?” should be followed by a question to clarify the answer and invite the interviewee to share related experiences like: “How and why did it change the disaster vulnerability?”. The interview guide can be found in Appendix 2. The validity of the research will thus be assured through data triangulation and by maintaining a clear chain of evidence with the research logic of theoretical replication. The different methods that will be used can be seen in the different steps of the research strategy as adopted from the multiple-case study procedure (Yin, 2014), which allows for visualization of the chain of evidence:



Figure 8 – The chain of evidence including subsequent steps of the research strategy and methodology

## 3.2 Case Selection

The case selection is mainly based on the functional disaster risk reduction strategy, but as this research is interested in collaborative landslide risk management, community participation was another prerequisite for the case selection. With that, two of the five strategies of the DRR framework of the Civil Defense, mitigation and recovery, were already less likely to become an option as a case study, because of the fact that these two strategies usually consist of highly technical and very expensive measures, not likely possible to be undertaken by the communities.

Although less likely, in the process of case selection no strategies were left out beforehand when looking at CLRM programs, because of the fact that the favelas have shown to adopt many different practices that are generally considered too difficult for communities, like housing, drainage and even electricity networks (Holston, 2009), meaning that with such an innovative environment all strategies had to be considered.

Another selection criteria was the size. There were many small community projects, but this would have resulted in less data availability regarding policies and previous research, which for the chosen programs have proven to be large. The last determining factor was locality; as only a similar context allows for systemic comparison (Yin, 2014). Another interesting CLRM program was found outside the municipality of RJ, but the choice was made to stay in the context of the municipality for this research, as it allowed for better comparison and focus on municipal actors.

The case selection was thus based on the following criteria, which are in order of importance:

1. Different DRR strategy for every program
2. Great role for collaboration between government and community within program
3. Program of large enough scale to ensure data availability and sufficient interviewees
4. Located within municipality of RJ

### 3.2.1 Mutirão Reflorestamento; Prevention

Ecosystem-based disaster risk reduction (henceforth: Eco-DRR) is based on preventing landslides rather than removing the vulnerable households. Eco-DRR is based on reforestation and protection of native vegetation on hillslopes. To illustrate the importance of vegetation to preventing landslides: the Brazilian Ministry of Environment found that of the 657 landslides analyzed during the worst event in the state of RJ in 2011, 92% involved anthropic alteration, and only 8% occurred in preservation areas with native vegetation (Frank, B. et al., 2019). Although Eco-DRR has not been executed, participatory reforestation has existed as long as 40 years already. The Program of Collective Reforestation, Mutirão Reflorestamento, aims to expand and connect the largest remaining native vegetation by means of community engagement. Reforestation is an effective LRM measure as it leads to slope stabilization as well as rainfall retention, the latter being the main trigger of landslides (Sandholz et al., 2018). However, biodiversity protection is the main objective of the program, not landslide risk reduction. This has as a consequence that its potential for landslide reduction is not exploited. Other Eco-DRR measures consist of flood controls by the use of free spaces, multifunctional landscapes and the greening of riverbanks by implementing restingas, which are not applied yet.

The government claims that it wants to get involved in Eco-DRR in its Climate Change Adaptation strategy, as they state they aim to start making conservation areas effective with “an

integrated urban environmental design that enables protection of native spaces and benefits the population, such as encouraging the creation of natural reserves and urban / native parks” (Municipality of RJ, 2016b, p. 61). They state moreover that monitoring by community patrols should ensure preservation and security of the area. The government thus shows it has the willingness to increase the adaptive capacity of society in order to minimize the vulnerability of communities. Until the landslide disaster in 2011, there had been little awareness on possible contribution that communities have for LRM (Sandholz, 2018).

### 3.2.2 Alerta Rio; Preparedness

The planning measures for preventing landslides events can take the form of building codes and restraining urban expansion in the transition zone between urban and nature spaces. These measures are interesting, but have proven to be ineffective in the favelas. First of all, informality of the areas makes regulation difficult and history learns us that the limits set for urban expansion are ignored. Secondly, it becomes increasingly difficult to define the transition zone in the first place, with an ever expanding city due to the continuous urban sprawl. With the favelas thus not going anywhere, there should be strategies to cope with the risk better, e.g. in the form of preparedness.

Preparedness is based on decreasing the population’s exposure to landslide risk, and it can be seen as the non-structural counterpart of mitigation. It is based on the same resilience thinking: engineering resilience. It does not aim to ‘build back better’, but only to create robustness. The most important preparedness measure is the recently established community alarm and alert system Alerta Rio, which is based on evacuation. Since 2011 the government has started involving communities in a early-warning system and evacuation program. These precautions can minimize the impact of natural disaster significantly, as communities are prepared for disaster events and can evacuate when risk is imminent. Rain gauges are installed all over the city to monitor dangerous amounts of rainfall; i.e. an amount that can trigger landslides. When they measure a dangerous amount of rainfall in a short period of time, the local leaders are expected to start the evacuation procedures, which is a clear shift from top-down to a more bottom-up approach. Although the alert system existed long before, only after the 2011 disaster the authorities have made communities partly responsible. Alerta Rio now works with local community leaders, and gives them landslide risk information specific for their neighborhoods, to prepare them better to take action.

### 3.2.3 NUDEC; Response

Although the government have not seized the opportunity to involve the community in Eco-DRR measures, the government did start to train communities for response measures. The civil defense is responsible for these trainings, which teaches communities new skills that make them less vulnerable and enables communities to act in times of crisis before the authorities arrive. Preparedness and Response both focus on the consequences rather than the hazard of landslides itself; and they also both work with non-structural measures. However, the biggest difference is that with preparedness the goal is to get people out of the risk area, not to make lasting changes. There is therefore a fundamental difference between the two strategies, which translates to the resilience thinking again: whereas preparedness does not bring about systemic changes, response does. Response therefore can be placed in evolutionary resilience, because it aims to help the community in risk areas to evolve from vulnerable victims to capable emergency actors (Defesa Civil, 2017). This is what is stated as the goal of the response program NUDEC, which trains community emergency groups to act in times of high landslide risk or in the aftermath of a disaster.

### 3.3 Program operationalization & evaluation

In this section the evaluation of the selected cases will be elucidated. The first step is establishing indicators for function and structure, and the second step is determining program performance. Operationalization is based on the DRR perception analysis of Schelchen et al. (2017), which is relevant because it investigates participation of Eco-DRR projects in the state of NJ. The analysis included the perceptions of vulnerability, responsibility and opportunity of the community towards participating in Eco-DRR measures. This research chooses to adopt vulnerability, opportunity and responsibility as the *index* for analysis: a set of related indicators that allow for systematic comparison across projects (BetterEvaluation, 2020). The first aspect, disaster vulnerability, will address the question if and how the intervention has changed the community's vulnerability towards landslide risk. The latter two variables resonate with the most important aspects mentioned by Zuidema (2016) for community engagement in environmental planning: ability and willingness. These variables are relevant because it is a proven method for landslide related research in NJ, and because it has close affinity with the post-contingency planning theory. The semi-structured interview questions regarding participation in terms of disaster vulnerability, opportunity and responsibility are adopted from the participation analysis framework proposed by the Norad Evaluation Department.

#### 3.3.1 Structure Analysis

The structure analysis concerns the collaboration between state and society. At the center of this analysis is hierarchy and responsibility; which will be analyzed through the variables decision-making power and the interest of participation. Decision-making is analyzed by determining who makes what decisions. The interest of participation is analyzed through White's (1996) and Cornwall's (2008) typologies. These typologies are useful because they avoid normative judgement about participation and do not assume causal relationships for the different participation forms. This means that there is no predefined link between the type of participation and performance, but instead, it offers a checklist that aids the assessment of causal links. These interests are divided in participation to reach cost-effectiveness, as a means and an end, or determination of the community's own development. By understanding the motives and reasoning for choosing a specific participation form, and comparing it to the observed objectives and outcomes, the effect of different forms of participation on the quality of the LRM program can be evaluated and compared. This tool works with case studies that are typical rather than exceptional cases, in order to validate the typology of interests as suggested by White (1996) and elaborated by Cornwall (2008).

#### 3.3.2 Function Analysis

The function analysis examines the programs functioning; its objectives and practices. The indicators for function are related to opportunities for the participants; program objectives (state, community or shared) and capacity-building (existent or non-existent). The choice for a particular function should be made based on the desired outcomes. When opted for decentralization, environmental ambitions should be balanced or combined with alternative local ambitions. Decentralization means shifting power to the local level so as to promote proactive, integrated and tailor-made approaches. However, willingness of the community to take responsibility is key, as responsibility comes with burdens that are shifted from a powerful government upon the shoulders of vulnerable communities. Getting rid of these burdens is sometimes even the very reason that governments promote this form of governance (Davoudi, 2012). Therefore, capacity-building is equally important to local objectives, in case of decentralized governance. Complex tasks like disaster relief can not be assumed to be undertaken without proper capacity-building; in this research referring to training and resources provided by the state removing constraints (Andrews et al., 2013).

### 3.3.3 Program Performance Analysis

Program performance is evaluated by the changed disaster vulnerability. The first data collection technique is policy analysis. The stated objectives will be determined through the analysis, review and interpretation of program policies. The determination of the objectives informs not only on the intended function of the program, but also on if objectives are reached or not, which can be the basis for conclusions on the performance. However, Carden (2009) urges to go further and ask how objectives were reached, if it was because of the influence of the project or rather the influence of contextual factors? And if the objective was not reached, why did that happen? The documented objectives and outcomes will first be analyzed through a policy review, and then compared to previous research on the programs, as well as interviews with actors within the programs. Any inconsistencies between the two will be subject to the semi-structured interviews. This data triangulation will help differentiate between internal and contextual influences on program performance and determining the effectiveness of the performance. The conclusions on performance will be subject to theoretical feedback, along the guidelines of post-contingency theory.

Then, moving beyond the single case level, there will be a synthesis of similarities and differences across cases, to find out if patterns among outcomes exist (Goodrick, 2014). This level of the research will shed light on the question if there are comparative advantages between the different programs, which comes down to the differences in configurations. Each configuration has different benefits, but not all combinations of function and structure match (Zuidema, 2016). Even though there is not one right configuration for every context, there still exist a variety of good fits and mismatches regarding the compatibility of function and structure for the specific context. The following section will be a detailed analysis of the programs that make up the case studies, through policy review, previous research and semi-structured interviews.

## Case reports

### 4.1 Mutirão Reflorestamento

#### 4.1.1 Policy review

In the 1980s, the Mutirão Program was created by the Municipal Secretariat for Social Development of Rio de Janeiro, with the basic objective of urbanizing slums with the use of local labor of low-income communities. Sewage, drainage and roads were implemented in several slums in the city. The rapid expansion of slums on the slopes led to deforestation and, consequently, an increased risk of landslides and floods. Therefore, reforestation was made a part of the set of already existing interventions as of 1986. Over time, with a greater technical and administrative structure, there has been a vast increase in number of communities that participate (Municipality of RJ, 2019).

The reforestation part of the program grew bigger, and in 1994 it became a program on its own: Mutirão Reflorestamento. It was transferred to the Secretary of Environment (SMAC). The program has contributed significantly to the increase of forest coverage in the municipality, without losing its main characteristic of social inclusion. Therefore, this approach can be positioned further along the spectrum towards communicative planning than activity-specific participation. Even though participation is seen as the means rather than an end, the community can state themselves what they think should be done in its neighborhood. Reducing the probability of landslides is the priority, but development of the informal settlements remain in close second-place (Restemeyer et al., 2015).

The Mutirão Reflorestamento program is nowadays labeled as one of the principle programs of the Secretary of Environment of the municipality of RJ, due to its long-lasting existence and its accomplishments. The program has received international attention due to its innovative participative structure, and SMAC states that the collaboration between state and communities is the main factor for success of the project, because besides the improved quality of the environment it has generated possibilities of employment, raised awareness and resulted in effective community control of risk areas. In 2019, the program was undertaken by 100 different communities and employed 15000 workers that were responsible for the reforestation of 3400 hectares of land throughout the municipality (Municipality of RJ, 2015). The program works as follows:

- The community requests SMAC to start the reforestation program in their neighborhood
- The application is then revised on: 1. Presence of organized community; 2. Presence of deforested steep slopes; 3. Presence of irregular settlements in permanent conservation areas (APP's) 4. Susceptibility of the watershed to flooding.
- When approved, the community lists the residents that are interested in participating
- Field teams are formed existing of 7 – 11 participants and one supervisor, using technical criteria. All the participants receive training before starting the reforestation.

At the start of the program the community is provided with, tools, protective equipment, uniforms and supplies including fertilizer, pesticides and seedlings. SMAC is self-sufficient, as it produces 170 different types of seedlings in five different nurseries, and the general aim is to plant the species that are native for the area. The participants, called 'Mutirantes', are assisted throughout the whole project cycle, from seedling production to implementation, by experts from SMAC. In 2015, the program started choosing the areas for reforestation more precisely, with a cost-benefit analysis that indicates areas that can be reforested most effectively. The municipality furthermore mentions 7 of the greatest benefits of the program (Municipality of RJ, 2019):

1. Soil containment and slope stability in landslide risk areas
2. Reduction of erosion
3. Reduction of flood risk
4. Greater environmental awareness of communities
5. Improving quality of life in communities
6. Creation of job opportunities; for 60% of participants this is the only source of income
7. Reduce the chance of participants to get involved in illegal gang-related activities

However, they also mention some important obstacles that have yet to be overcome:

1. Illegal cattle herding in the reforestation areas.
2. Frequent fires in the dry period, which is enhanced by the presence of invasive grasses.
3. Gang- and militia-related violence, which hinders and sometimes ends the project.

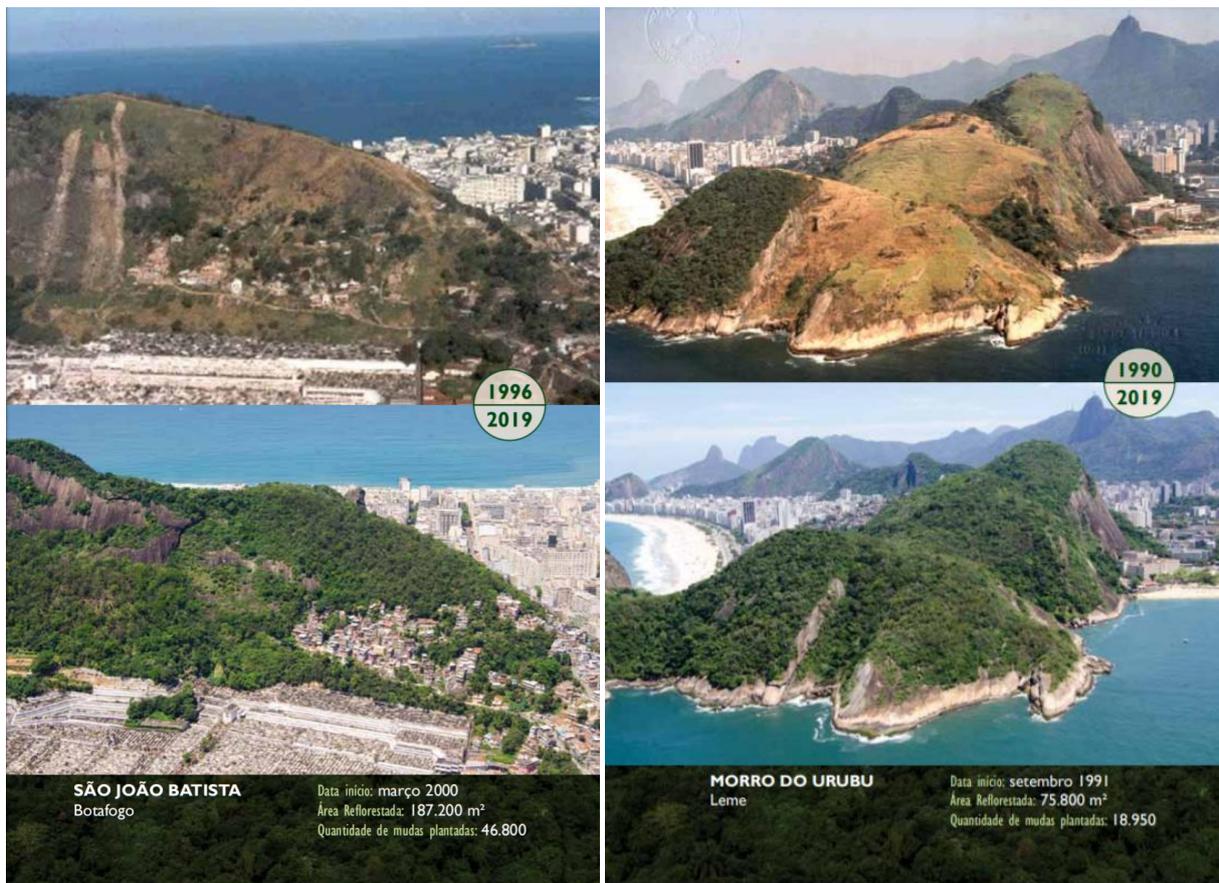


Image 1 & 2 - Reforestation of hills in the São João Batista and Urubu neighborhoods, showing start date, reforested area and number of trees planted (Municipality of RJ, 2019)

#### 4.1.2 Previous research

A study of Lange, Nehren & Sandholz (2018) examines how urban resilience can be strengthened through ecosystem-based measures for reduction of landslide risk in Rio de Janeiro. The Mutirão Reflorestamento program is discussed extensively, especially the renewed cost-benefit analysis. According to the authors, the multi-criteria prioritization methodology considers these criteria:

- Adjacency to existing forest fragments;
- Adjacency to existing reforestation projects;
- Proximity to informal settlements less than 1,000 meters;
- Within an environmental conservation area;
- Area size bigger than ten hectares;
- Access via public road;
- Landslide risk;
- Slope higher than 30 percent; and
- Slope orientation to north.

The criteria are in order of importance, and the surprising fact is that landslide risk only comes in seventh in the ranking. In the prioritization formula it gets the lowest value of four, whereas the adjacency to existing fragmented and reforested areas get the highest value of 19.

Another finding by Lange et al. (2018) that is rather contradicting with the program policies also involves the locality of reforestation. The authors state that there is good cooperation with fellow governmental institutes Geo-Rio, Rio-Águas, and other SMAC units, but poor cooperation with the urban planning unit. A SMAC expert reveals in an interview conducted by the researchers that reforestation has taken place mainly in unsettled areas, and to a lesser extent in and around favelas. This is remarkable, as in the policy it is stated that the regular procedure involves a request from the community for reforestation of the area adjacent to their neighborhood. The interviewee mentions that in the future more populated areas should be prioritized and that the multi-criteria tool should be revised in order to make that happen. Other criticisms that the interviews highlighted were of financial and criminal nature, which is in line with the obstacles mentioned by the program policy.

Besides the interviews the researchers conducted fieldwork in two favelas that suffered landslide events in the 2011 event. Several risk factors became evident, including precarious housing construction and location, landfills, poor or absent drainage, and environmental degradation. In one of the favelas the Mutirão program was underway, but especially the deposit of waste was hindering the recovery of the area. The authors thus suggest that monitoring and maintenance should be improved to ensure the protection of the reforested areas. The authors give two suggestions to resolve the problem; the introduction of (native) tree species that could have added value for the population besides landslide risk reduction, that can produce fruits or other products; and the implementation of Payment for Ecosystem Services (PES) that entail that local communities are awarded not only for one time reforestation, but also for long-term maintenance.

The research concludes with targets for action, the following of which are important for this project:

1. Development of an effective monitoring system for recuperated areas;
2. Extension of existing programs on awareness, preparedness and social responsibility of the local population for the environment in general and natural hazards in particular;
3. Creation of incentive systems for ecosystem-based measures with PES schemes;
4. Integrating tree species with a direct or indirect economic value; and
5. Improve the cooperation between actors in urban planning, ecosystem management, disaster risk reduction, and climate change adaptation to create hybrid solutions.

### 4.1.3 Interviews

#### **Function; Objectives**

The program founder explains the evolution of the program and its objectives:

*“Mutirão Reflorestamento is a very rare case of public policy and project in the environmental area that has lasted as long as it has. I and another team of forest engineers that were hired by the city to develop this project in 1986. In the 1980s at the city hall of RJ, several slum urbanization projects were initiated, so the projects involved drainage, paving, construction of sewage networks, but since the beginning one of the problems that the favelas had was the risk of landslides, so the city decided to include reforestation in this list of works. Not only to contain the slope, but also to prevent favelas from expanding into risk areas”*

The current program coordinator confirms that reforestation became part of the program place to make sure that the favelas did not expand any further. Thus, not only the protection of the favelas, but also their restriction is the objective of the reforestation. Nowadays, the program has a great number of objectives:

*“Today, we are learning that the idea is not to plant trees, but to plant a forest. Today the work is not only ecological, but also containment. Today we have several proposals and objectives: to reduce the risk of landslides, to reduce the growth of communities in areas at risk, to generate income for groups of residents in situations of social vulnerability, to increase biodiversity, to connect forest fragments, to create environments for fauna. We try to connect all of these goals”.*

The program has been so effective with reforestation, that the main focus has shifted from actual reforestation to conservation of the reforested areas, and the addition of the programs very own seedling production:

*“after 20, 25 years, the part of the reforestation task force that works in the community has nowhere else to grow [...] Today the part of the Mutirão project focuses more on maintaining what has already been done and correcting areas where the ecological part has not been done in a very correct way, to increase biodiversity. The project has 5 seedling nurseries and our capacity is over 1 million seedlings / year. We have a seed collection team, both in the municipality and outside the municipality, precisely to increase in quantity and quality [diversify the genetic pool].*

The environmental agent, who is from the community where he works, is very clear:

*“From my own experience, I am sure of it [its effectiveness]. In my opinion reforestation is more important [than infrastructural measures], because the infrastructural measures do not deliver the various outcomes that reforestation does provide”.*

One of these outcomes is agroforestry, which makes for the possibility to adding social-economical value to the new forests, besides DRR and biodiversity. The program thus seems take its additional objectives seriously, like generating income for socially vulnerable groups:

*“The planting fruits depends a lot on the technician once again. Agronomists work more that way, they try to make that connection [...] Some technicians try to put an orchard in the lowest part, if possible, and then move on to the reforestation part. It depends on the case”.*

The program initiator, has many more ideas on increasing objectives that can benefit the community, if their lack of investment is sorted out:

*"I think the project could also cover more activities besides the reforestation fronts. So we could have: reforestation fronts, vegetation management fronts [that is, the vegetation is already consolidated, but it needs to be managed and conserved], they could also have teams to do services within Natural Parks, the city government could hire these workers to do 'park ranger' activities, which would generate jobs and increase the conservation of the reforested areas [...] parks have virtually no staff. So there are few people to take care of the park, sometimes there is only one employee who is also the manager [...] So there would be many possibilities for work, for example, maintenance of trails, management of the park's internal vegetation, control of invasive species, signaling, or environmental education".*

### **Function; Capacity-Building**

When asked who gets the opportunity to participate, the program managers responds:

*"When the request comes from the community we first assess whether technically, financially and structurally this work is viable. Then we present the project, and the community - via the person in charge - presents the teams. We don't choose anyone. And they are not city officials, they work for themselves and receive a scholarship from the city because nobody works for free right".*

Accept for financial incentives, the participants receive trainings to require diverse skills:

*"What we do is for the technician to decide, there is a project and this area will be mapped, and that area is divided into sectors. The foreman receives this map and over time he understands this map better, they have training, and receive a basic handout on 'how the pit size should be', 'how to make the cut', 'part of the soil that you use', 'how to plant seedlings'. They are trained for all this".*

When both participants are asked about what they learned from the program, they showed to have a deep understanding of the risk reducing powers of reforestation. One of them responds:

*"A hill without a tree is without security, the roots of the trees hold these hills, bring security."*

The other one adds:

*"With the vegetation cover, the energy of the summer rain is reduced, so the part of the water is captured and is slowly absorbed by the soil. I gained knowledge of the area in which I work [...] I learned how to recognize the soil and make its correction and protection, respect the spacing between seedlings, the importance of the preservation of animal species and the conservation of fauna and flora."*

One of the agents explains the program has created great opportunities for the community:

*"I work here with 7 employees and the opportunities have increased. There are people who work with me who hardly know how to write, so for a person who has no education it is difficult to get a job, because you have to fill out forms. Here, the only forms they fill out are for the bank details and the time sheet. So the work in the communities increased, yes, the communities that have this program also have more job opportunities".*

Although the programs have benefitted both communities and its population, the agents both also state that the opportunities to properly do the job itself are not always optimal:

*"There are not enough resources, it would be necessary to increase financial investments and new knowledge techniques, through training. I think there are resources to make participation more effective and as for training, on a daily basis here we pass the training as we pass it on to our employees. What is little I think is money, the salary is little here. The guys don't even earn a full*

*minimum wage. There is a lack of resources, moneywise especially. They could improve their salary. Our work material such as tools, uniforms, this could all be improved too. But we have to live together like this, at the moment it's what they give us to work with so we have to do our job, maintain our forests and if one day it gets better we'll thank you".*

The program manager agrees with that statement:

*"...nowadays we don't have the capacity to increase works because we don't have enough teams. We needed to review the whole issue of our logistics, due to a lack of money we don't have so many cars, materials, tools, supplies. We always work with the bare minimum today. I cannot say whether this is due to lack of money or because it is lack of investment priority for the government".*

### **Structure; Decision-Making**

The program manager explains the division of responsibility between government and community in the program:

*"The community will appoint a person to be in charge, we do not choose which people are going to work. We do a minimum test because the person in charge must know how to measure an area, fill out a productivity report, and have to know a little leadership, meaning he should know how to relate to people. So this supervisor chooses his team, sometimes 5, 10, or 12 people. The person in charge is responsible for controlling the work of the team, making them sign the 'hours worked' sheet and he must tell the technician what happened there on the construction site. If for some reason the foreman decides to leave, we try to choose someone from the team to be the foreman, or ask the residents' association again to choose a foreman."*

The community has the responsibility of requesting the project in their community, and they have to pick their project leader. Then, their responsibility increases as the project develops:

*"...the technician is constantly in the community inspecting at the start, but with the passing of time the technician can go less often because the team already knows what to do and how. There are works that you know you don't need to inspect for a month because the team is extremely active and committed, there are works that if you don't go every week it doesn't work well".*

The environmental agents that were interviewed, however, are very excited about their work and eager for more training and responsibility:

*"[besides what I learned already] geopolitical issues are also of interest to me. For this reason, I am prepared to take on new responsibilities".*

The other agent explains their responsibility is huge, not only regarding landslide risk:

*"Our responsibility within this project is very large due to the areas we work in. We work in a risky area, not only of landslides. It has 'parallel power' [gangs / militias], so we have to have a big responsibility to put the boys to work, someone has to go up to work with the boys, so we go up with them. Because when there is a group working at the top of the community, when confrontation occurs, it is a great despair! We have to be gathering people to go somewhere more safely, so I think this is a huge responsibility, you are responsible for 7 employees at the top of the community. With a huge shooting, you have to think quickly what you are going to do, because you can't get down in the middle of the shooting. So I believe that this is part of the responsibility that we have, for us to practice another function besides reforestation, I assure you that it would be difficult".*

Besides that they are trying to create more security in regard of natural disasters, the participants cope with daily security issues of gang-related violence. It is questionable if people in such vulnerability should be given the responsibility of decreasing landslide risk. However, when they are given such responsibility by the government, they should at least be rewarded for this time-consuming practice as it does not allow other jobs on the side.

### **Structure; Participation interest**

The program initiator explains that participation exists to create job opportunities:

*"Its strong point is to generate job opportunities for populations in need, so this project, for example, at its peak reached 1000 workers on the work fronts. It is the environmental initiative that generated most job and income opportunities in areas where employment is low.*

But he explains that the participative nature of the program is also instrumental in its effectiveness:

*"...since the beginning we have been recruiting residents in the favelas, so as far as they worked on the project, these projects have been preserved much better than similar projects that hire companies. Because residents themselves participated in the planting, they conserve the area".*

The current program manager agrees that participation is key in effective conservation:

*"So I would say that we that the participation works because 1 - we stay in the community 2- because we 'convince' the resident, since he worked on that land, weeded, planted, did a lot of things there, he himself wants to protect that against deforestation. Of course, there are people who don't care much, because they don't get that much money, etc., but there are people who care.*

The program manager thinks that conservation is effective, for one because of the autonomy of its participants and the genuine interest of them in their work. However promising, when asked the same question to one of the environmental agents, he has a more nuanced response:

*"In the 20 years of reforestation here in the community the results have been good, but not everyone respects the conservation, so the conservation in my opinion is not as effective as the reforestation".*

### **Performance; Vulnerability to Landslide Risk**

The program initiator explains that landslide risk is diminished greatly by the program, as most degraded hillsides in the city have been reforested already.

*"More than half of the reforested areas were in risk areas, also indicated by GEORIO. Some very critical hills [...] with a history of landslides never had landslides after they were reforested, so the project effectiveness is very great. There is also the retention of soil sediments on the slope, from surface erosion, so the amount of sediment that arrives from the reforested areas is much lower than the amount that arrived when the area was degraded. The strong point is the continuity, even though the changing of management at the city hall, so the results are much better than any other work that is been done [by the municipality]. We have turned degraded areas that have been reforested into the most renown municipal parks".*

The environmental agents agree that the program has been effective in their communities:

*"The risk of landslides has changed a lot, so far with these 16 years of reforestation here there have not been any landslides. After the project entered here, the trees grew and held the hills".*

*"The reforested areas bring a lot of security, in the old days without the trees, all the rain resulted in landslides. Debris came down, caused problems down here, the debris that came from the top of the hill. And with trees now, we never had this problem here in the community [anymore]".*

## 4.2 NUDEC

### 4.2.1 Policy review

Núcleo Comunitário de Defesa Civil or NUDEC is the community civil defense nucleus. The NUDEC agents are the link between the government and its community, leaving communities better prepared for disasters. In the policy for formation of NUDEC agents by the Civil Defense (2017) can be read that communities are strengthened through participation is an important strategy to by creating widespread volunteer networks, trained by the Civil Defense, which share knowledge on disaster risk reduction and provide immediate assistance and relief in case of a disaster.

The key objective of community participation according to the Resilience Policy (Civil Defense, 2017) is immediate assistance in case of disaster events, which only the community affected themselves are able to. It is the quickest way of humanitarian aid, especially in natural hazard events where roads could be blocked and communities become difficult to access. Capacity-building makes citizens in vulnerability become agents of change, as they learn how to act and help others in case of disasters which results in their empowerment and inclusion. A prerequisite for success is voluntary engagement and commitment.

The specific objectives of the NUDEC program are the following:

- To develop a greater number of people living in areas at risk perception and awareness of the threats and vulnerabilities to which are subject to, as well as creating a culture of prevention and resilience for the citizen;
- Encourage changes in behavior, for adherence to actions preventive and mitigating measures so that we know what to do in situations of emergency;
- Encourage the initiative so that the community itself comes to solve the malfunctions in the various existing services, not being held hostage government bureaucracy, which can allow the impact on the environment causes damage that results in degradation that poses a risk housing, bringing catastrophic consequences for the entire local community.
- Raise the awareness of the community to mobilize in order to carry out meetings to address the various existing problems, and find their own solutions.
- Encourage the participation of institutional partners, social organizations or private entities that can contribute to the solutions raised by the NUDEC's.

The volunteer is described as a person with a high civic spirit, that devotes part of his time to social welfare activities. His aim is to transform the reality of communities by building trust and networks within them. Motives for residents to become volunteers vary from solidarity to wanting to make a difference. It is important that volunteer work comes from personal desire and that it is never imposed. The training of volunteers exists of the following tasks:

- Basic notions of the Civil Defense
- Volunteering terms of the Civil Defense
- Risk perception
- The community Alert and Alarm System
- The training sessions and projects of SUBDEC
- Fire prevention and fighting
- Health prevention
- Psychological intervention in communities
- Basic life support

The disaster that occurred between April 5th and 7th, 2010, in which 67 people died, all living in informal communities located on hillsides, has been a turning point for the Municipal Civil Defense (Municipality of RJ, 2013). Since then, there has been invested in strategies with the aim of making communities more resilient, meaning there is greater adaptability to absorb the impacts of adverse events, as well as enabling a quick return to normality. Since 2010, the Civil Defense started training the agents, and in 2013 there were already 5200 graduated community agents (Municipality of RJ, 2013). The trainings consist of lectures with a workload of 12 hours per class, including a lecture on risk perception and prevention given by the Civil Defense; a lecture on the Alerta Rio system given by the Civil Defense; and notions of first aid (given by the Brazilian Red Cross). Moreover, evacuation simulations are performed by the agents after graduation, as evacuation can only be efficient when agents and residents alike are trained in periods of normality. Simulations are carried out as close-to-reality as possible, with as goal to ensure a natural, fast and safe evacuation for residents to assembly locations (Municipality of RJ, 2013).



*Image 3 - Graduation of NUDEC agents, in presence of the mayor, with the delivery of the diploma, vests and equipment including, lanterns, whistles and raincoats (Municipality of RJ, 2013).*

#### 4.2.2 Previous research

Although unfortunately no previous research on NUDEC's in Rio de Janeiro could be found, there does exist scientific evaluations of NUDEC's in other parts of the country. Baltazar (2013) executed a detailed analysis of the NUDEC in Butantã, a municipality in São Paulo, and found that the NUDEC there has a wide range of objectives: to stimulate and guide environmental preservation with the community; develop and participate in campaigns for risk reduction; collaborate on prevention and emergency plans; inform the municipality about natural degradation; and distribute the knowledge acquired on risk management throughout the community. The communal importance of the NUDECs exists of enabling participatory and democratic spaces in the community; stimulating experiences from community actions developed by the civil defense; building a believe of possibilities for change in the community; promoting integration between civil defense and community; encouraging the population to construct a risk prevention culture; and enabling individual development in a sense of awareness and activity. Promoting the training and evaluation of NUDECs implies human and material resources, and establishing guidelines to support the planning of socio-educational actions in the prevention of risks and disasters. Activities consist of gathering relevant disaster risk information; carrying out disaster simulations, which is a practical and theoretical way to prepare the population for possible risks; and conducting first aid workshops. The research concludes that NUDECs are very important allies for civil defense, but that it is paramount to keep the NUDEC volunteers motivated to participate in the actions, which was achieved in Butantã, where successful collaboration exists for almost a decade. It is also necessary for NUDECs to have confidence in the Civil Defense, whom in turn should commit to respond to the demands of the community, which generates the credibility of the Civil Defense in the community. The dissemination of a prevention culture needs to be developed with greater commitment by the public authorities and by society.

A study by Da Silva Rosa et al. (2015) evaluates a NUDEC in Recife, in the North-East region of the country. The study is "justified by the inefficiency of structural actions (engineering works) for disaster risk reduction (DRR), given that disasters associated to landslides and floods continue to increase in magnitude and frequency" (p.210). The authors wish to shift DRR actions towards decreasing the vulnerability of populations in socio-environmental risk situations. Here, the NUDEC executed an education project teaching young students, between 10 and 15 years old, how to carry out community planning in favor of self-managing disaster risk. The project resulted in the construction of a youth NUDEC, which has been contributing the civil defense in Recife with their ideas on socio-environmental risk prevention. The civil defense in return gives workshops on risk perception, first aid, human rights in risk and disaster situations, socio-environmental risk prevention and mapping. The analysis concludes with very positive findings on the education program. First of all, 95% of the participants stated that they thought the education program was very effective in helping the community to live with risk and understand what to do in an emergency situation. Secondly, the interaction of state and community gave rise to joint decision-making, which the policy-making input of the youth NUDEC is a good example of. Thirdly, education develops citizen conscience and community members assuming that they are actors in transformation, being able to invest in processes which can lead to real change, al mentioned in the analysis of Baltazar (2013).

Most importantly, according to Da Silva Rosa et al. (2015), the poor Brazilian urban communities are often not aware of their high environmental risk due to natural factors and a lack of infrastructure. Education is therefore the very first step, as it provides knowledge of these risks and equips people to deal with them. The project analyzed in this research enabled better risk awareness and communication between the communities and the state, providing a new approach to tackling disaster risks. The research found that ongoing dialogue and continuity of the program is key to reducing the effects of adverse natural disasters.

### 4.2.3 Interviews

#### **Function; Objectives**

The coordinator of the NUDEC program, responsible for the community trainings, explains the main strategic function of the Civil Defense and its relation to the NUDEC program:

*“The municipal civil defense is responsible for prevention, bringing information to prevent the disaster from happening and if it happens, it is minimized by the awareness and learning of a certain group of people. [...] The main project in the case of landslides is NUDEC, we take the information to a small number of people, it doesn't have to be a large number, but it must be a number of people committed to passing this information to other people. We empower this group by providing basic first aid information, fighting fires for example, so that they can give the first response in the event of a disaster in the community.”*

When asked to clarify the main objective of the NUDEC, the response was:

*“The main objective of NUDEC is that there is a group of people to give the first response in case of disasters, because even before civil defense or firefighters arrive, someone can always start by doing something. And this is a community practice already, someone always wants to help do something, so our idea is to train these people so that their immediate response can be more technical, until the professionals arrive”.*

The objective for the NUDEC's can thus be defined as creating an extension of the civil defense in all informal communities where trainings are provided.

#### **Function; Capacity-Building**

The president of the resident association, that has worked with NUDEC since the beginning of the program, is positive about the program, as it builds lifesaving capacities:

*“NUDEC is important, not only for the community. It gives you ways to get out of different situations, because it is a 'first aid' but more advanced, because you have a little knowledge of each thing, for example, the importance of turning off a gas cylinder in these cases, or of solving some problem with electricity, turn off the main switch. The course helps you to be resilient towards various types of incidents, to have the ability to anticipate and save lives, instead of running and thinking that 'you are getting rid of the problem', sometimes you have to minimize the problem, not even solve, but you have an ability to minimize the problem”.*

The program coordinator explains why the extensions of the civil defense are essential for disaster risk response. Their response time are even quicker than the governmental services, because they are already present in the most risky areas, and they have vital local knowledge:

*“In the community training, it is important that this person can pass correct information to the technical team, for example: do not enter on X street because a pole fell there, or the quickest access is via Y Avenue. We also have a protocol in case of general disaster to ask for help from the community health worker - this person works in hospitals or health posts in the community and usually also lives in the community - so he has information about the health condition of people in that community, who is a priority of assistance such as pregnant women, the elderly, disabled etc. So they give information such as: we have priority to attend the houses x, y, z so the firefighters or civil defense must go there first”.*

The community leader explains that the program provided direct and indirect opportunities for capacity-building:

*“We had 2 classes, 30 people each. Yes, all knowledge is very important in the community, it even motivates the leadership to look for new courses for the community. We started with NUDEC, realized that the residents needed to have this knowledge, and automatically, they themselves asked for other courses for the community. It was there that we managed to partner with other institutions, and started other courses. It is basic knowledge, but it helps.*

When asked who was willing to participate in the program and why, the community leader responds:

*Many people participated, anyone could. Being honest I think that motivation is more the importance of trying something new, because of the lack of knowledge of many, so they see that course as an opportunity to have new knowledge”.*

The willingness and ability of the community to participate are the strength of the program, says the coordinator:

*“The community has a lot of desire. If there is a minimum of working conditions offered to them, they still completely adhere to the job. After I give the training, I should be able to offer the possibility of improvement, and to monitor what happens in the community throughout the year”.*

### **Structure; Participation interest**

The biggest vulnerability of the program, according to the coordinator, are continuity and structure. But at the heart of it all, is communication, which stops once the program is set up:

*“The biggest obstacle is in fact the infrastructure, and direct and continuous investment. All the communities where I went to train, should have assistance throughout the year, I should be able to help with the data collection questions they have to do, etc. But there is no continuity, and maintaining that contact is the most important thing after training. I believe that people in the communities do not need a salary to join NUDEC, there are very motivated people in the communities to help the collective, what is missing is structure”.*

The community leader explains that the continuity is hindered by politics:

*“The authorities start an action but don't stay with it. [...] They can do the beginning - middle and end. Because the community is new, they will only understand better when things start developing. Of course, we in the community need to do our part too, but we take this knowledge to the public authorities and they are always wanting to know 'which politicians own this area?’”.*

The program coordinator elucidates the influence that politics has on the program. Parties come in during election times, with many promises. But when election time is over, and their own interests are taken care of, they disappear, which hinders the long-term interests of communities:

*“The governments that has been taken over does not see this project as a priority, the lack of continuity is a big problem. If we could invest as little as possible so that people could continue to survey data in the community, communities would certainly be safer and more participatory. The community is alive, someone always someone builds something or destroys something, the ideal would be that for each problem that appears, I would be informed and provide the solution together with the community. It is important however that this data comes from the community so that we do not depend on 'political groups' bringing solutions, often political groups want to enter the communities and do a work that does not need to be done, just to win votes. It is important for the community to know what they need so that politicians do not come in, as they only serve the political interest; and not the community interest.*

## **Structure; Decision-Making**

The coordinator mentions a very interesting point when explaining the responsibility of the Civil Defense:

*“The project should have a better dialogue with other municipal departments, including engineers, social assistance, housing, infrastructure works, with all these sectors to better serve the communities. The role of civil defense in the municipality is exactly that: to manage the other secretariats of the city for the benefit of the community, but in practice it does not exist, instead of being a body that coordinates the structure, we become another body in the action of response”.*

It shows that the Civil Defense recognizes the bad cooperation and coordination, and that they are willing to take responsibility to improve the situation by taking on the role as coordinator. Better coordination would have more benefits, according to him, like top-down support:

*“If the city is unable to solve the problem with its own resources, it can ask the federal government for resources, but information should be shared - so that they understand that the city really doesn't have enough resources. This report sent to the federal government is made by the civil defense based on information received from each secretary of the city hall, but we often do not receive the information necessary to obtain the city's resources. This is because in many cases the manager of the secretariat for political or corruption reasons, keeps this information for him and does not pass it on to civil defense”.*

Transparency and collaboration between municipal bodies is thus key in tackling one of the biggest obstacles for all of the CLRM programs: funding and investment.

## **Performance; Vulnerability to Landslide Risk**

The NUDEC coordinator explains that performance can be improved significantly. The community is vulnerable in lots of different ways due to many lacking services, which exacerbate the landslide risk in diverse ways :

*“The community for example degrades the environment to build its residence there, in addition to causing this construction impact in an area that was once forest, it does not receive access to sanitary sewage infrastructure, so people usually make a pit in the ground , on the ground itself. In other words, without the threat of rain, the communities' soils are already soaked due to sewage, as it is also not part of the municipal water supply system. There are several triggers [...] so we should also consider this reality when triggering the alarm, as the soil is already soaked without rain. And these other important municipal bodies do not have as much contact with the project, do not support, and often do not even know the project. Only through the civil defense of the municipality”.*

The coordinator mentions a decline since the change of administration in 2016, due to budget cuts:

*“I would say it happened better, in 2016 it was the last year that I worked well with NUDECS, with a good structure. From that year on, cars started running out for example, and I had no way of going to the communities. The problem is that I don't have that possibility, due to lack of investments. I don't have the structure to keep up with the communities. There should be an investment of cars, for example, just to serve the community”.*

## 4.3 Alerta Rio

### 4.3.1 Policy review

The contingency plan of the Civil Defense (2017) consists of the chapters: Community alarm system; Community capacity building; Evacuation process; Activation of sirens; and Simulation exercises. The coordination in case of evacuation is done by the Centro de Operações Rio (COR).

#### **Community Alarm System**

The community alarm system is part of the DRR strategy of the municipality. The mobilization and preparation of the communities for evacuation is done by creation of NUDEC's: community civil defense groups, which consist of the leaders of favela associations, community health agents and environmental agents. These agents are provided with trainings for evacuation, and cell phones to receive alert messages and to communicate with the civil defense for free. Based on the landslide risk maps of Geo-Rio, NUDEC's have been formed in 117 different communities, and sirens have been placed in 103 communities. The location where the community will evacuate to is chosen by the community leaders, and simulation exercises should be performed constantly and become a routine.

#### **Capacity Building**

Since 2010 5200 community agents have been trained, through the community capacity building projects, or NUDEC's. The municipality has chosen for community agents because of their important local knowledge on social and environmental vulnerability. The community alarm system counts on these agents whom fulfill an important role in the mobilization and evacuation in case of landslides, in close cooperation with radio stations and the Red Cross.

#### **The Evacuation Process**

Evacuation is initiated by the alert messages from COR to the community agents, whom are then responsible to share the information with the community and to assemble them for temporary evacuation in the 'Pontos de Apoio', which translates to Support Points. When the rain gauges measure the critical rainfall amount, the siren alarm system is automatically activated. The rapport states that the use other measures of mobilization available to the community are encouraged, such as whistles. When the disaster risk has diminished, the community agents receive a message that the residents can return to their homes. Landslide occurrences should be reported to the Civil Defense. 20 Simulation exercises had been done in 2017, which included all the communities with the system.

#### **Final considerations**

The preparation the communities and the implementation of the Community Alert and Alarm System are fundamental measures in the DRR, especially in ensuring human wellbeing. In addition to these actions, other preventive measures should be present in the communities, like reforestation, infrastructure works, among them slope containment works and waste collection programs, as well as involving technology and knowledge on risk mapping and rain forecasting and monitoring in cooperation with the COR. Structural interventions in formal areas of the city and other macro drainage works are also essential. In addition to this, it is extremely important to encourage the adoption of sustainable practices like rainwater reusage, green roofs, draining pavements, increased vegetation cover, as well as continue awareness and educational campaigns on proper waste disposal of waste to prevent problems for the drainage system of the city. In this way, together with fast and efficient Response and Reconstruction, the Municipality of Rio de Janeiro may become a City Resilient to Heavy Rain, with a great capacity to face, adapt and absorb the impacts of this type of occurrence and restore normality as soon as possible.

### 4.3.2 Previous research

#### Evaluation of the community-based alarm system

Calvello et al. (2015) have analyzed the community-based alert and alarm system for rainfall induced landslides in Rio de Janeiro, locally called Alerta Rio or A2C2 (Sistema de Alerta e Alarme Comunitário para Chuvas Fortes), which is installed by Geo-Rio. The A2C2 landslide early warning system was deployed between 2011 and early 2012 in 103 informal communities of the city.

However, in the 1980's the first alarm system was installed. This system worked with rainfall monitoring but the data remained exclusive to experts of Geo-Rio. However, in 1999 they adopted a more open access philosophy when they scaled up to the whole city, making data available to the general public. This open access philosophy proved to be important for the developments the system would undergo in the future. In response to the 2011 landslide events, the system was updated to the community-based alert and alarm system.

In 2015, the system included 150 rain gauges and 166 sirens, which operate with 15 minute intervals. As can be seen in the figure below, there exists an attention and alert message. The alarms do not work automatically anymore, but the Civil Defense and the Centro Operacionais Rio (COR) decide if to issue a warning. The local agents are then informed that severe weather threats are imminent and expected to mobilize the community. These local agents exist of health representatives and volunteers, whom are members of associations called NUDEC's.

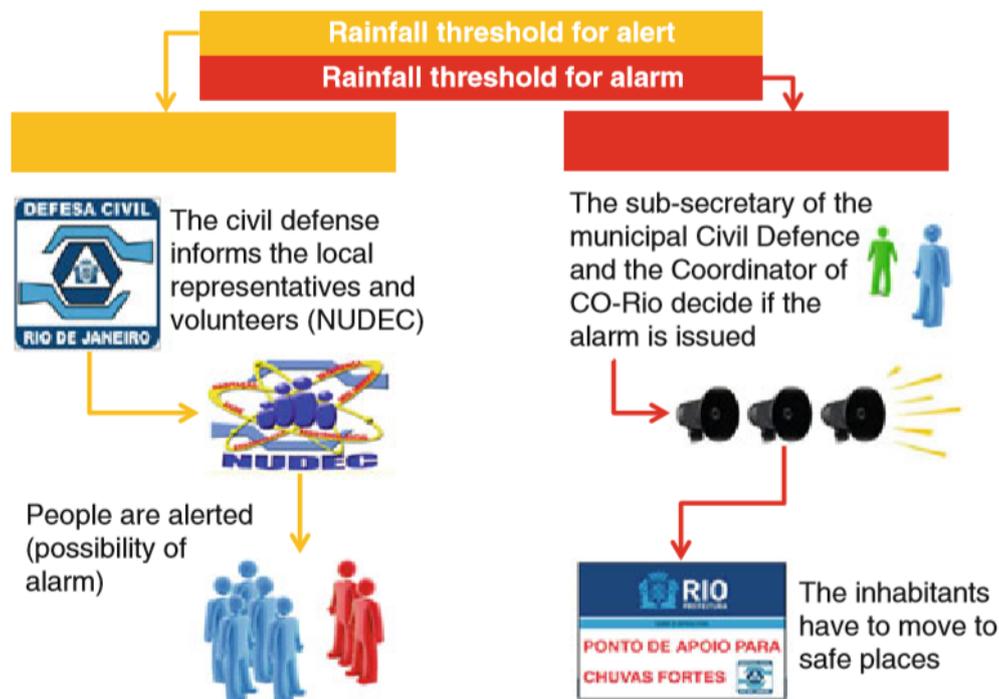


Figure 9 - Flow chart of the procedure for issuing alerts and alarms (Calvello et al., 2015)

Another more detailed analysis of Calvello et al. (2015) examines the efficiency of the system, which found that there was a low number of false or missed alarms. However, the research did suggest to adopt zone-specific rainfall thresholds, as at the time of the research there was only one single threshold which does not reflect diversity of risk throughout the city, and; that rain gauges could be clustered for the issuing of a warning; currently it depends on one single rain gauge.

A study by Bandeira et al. (2017) from the same year as the policy report evaluates the Alerta Rio system by means of community leaders' perception regarding the warning system. In total 71 community leaders were interviewed to discuss the system, and the authors concluded that the issues that were mentioned could be divided into issues regarding cognitive beliefs, the social- and physical environment. Of the 71 community leaders interviewed, 73.3% lived in their community for over 30 years, 84.5% had witnessed rain induced disasters, and some of them even participated in the disaster landslide event of 2011 with the rescue and relief of victims. 85.9% of them considered the warning system to be good or very good, which indicates a positive perception of the system. Moreover, 92% confirmed that the system was working properly and that the message of evacuation is clear. However, some 13% of the community leaders said that the safe places remained in dangerous areas, and another 21% complained about the quality of the safe space itself. Actually, Civil Defense states that only churches are usually big enough to host whole neighborhoods, so they often function as the safe space. 50% of the community leaders considered the municipality to have the central role in reducing the risk of landslides caused by rain, and that it must provide the communities with necessary infrastructure, slope containment and cleaning of the neighborhoods, 18% mentioned that the community associations were responsible because of local knowledge, 10% said that residents themselves are responsible because of risk enhancing building practices and waste disposal. The last 22% says that responsibility is divided equally among the three actors. Some respondents complained that the warning system should be complemented with infrastructure. They stated that the warning system allows city hall to "get rid of responsibility" in the event of disaster, while the lack of sanitation, urbanization, and containment of slopes is most important in DRR. They also complained about the lack of recovery measures; in case damage actually occurs, continue living in damaged houses or rebuild in high risk areas. However, the most noteworthy result was that 82% of the community leaders considered their own house safe, which the authors suggest might explain why 73% of them do not leave their homes when the siren is triggered. The leaders claim that the system works appropriately, but that people usually do not attend to it because of:

- They need infrastructure, not an alarm system (15)
- Stubbornness and laziness (11)
- Inadequate safe places (11)
- The fear of belongings being stolen when they leave home (4)
- The fear of undertaking evacuation itself (4)
- The fear of house removal by the government when they leave (2)

The lack of trust is the reason for the main response about the non-compliance to the evacuation system, because they think more structural safety measures are needed to ensure permanent safety. The authors state that a crucial objective is therefore to have accompanying measures, so to show that the evacuation is not the only investment in DRR. The authors also believe that awareness raising on the DRR practices they can undertake themselves would be helpful, as 50% thought that it was only the municipality that is responsible for DRR, while there is much residents themselves can do to reduce the risk. The other social issue, the fear to leave homes either because of theft, dangerous routes or house removal, shows that an effective alarm system alone does not guarantee evacuation. Understanding of the historical, social, cultural factors, the context, is essential. Lastly, the complaints about the safe places are interesting, as the report states that the community choose the safe places themselves. Either this does not happen in practice, or monitoring and updating is necessary. They conclude that active participation is necessary for proper functioning of Alerta Rio.

Tabel 3 - Summary of problems in the Alerta Rio warning system and propositions to solve them (Banderia et al., 2017)

reference

*Social environment issues*

<p>Skepticism of the concept of “risk area” and lack of trust in the politicians</p>	<p>Integration of the largest possible number of people in the community into the alert system (Fakhruddin 2015; Mulyasari and Shaw 2013; Parker et al. 2009)</p> <p>Communicate with transparency the criteria and process of uprooting and in the investment in infrastructure</p>
<p>Attribution of responsibility to the city hall for reducing the risk of landslides, also observed by Jaiswal and van Westen (2013) and García (2012) in warning systems for landslides</p>	<p>Reinforce educational programs, as indicated by Parker et al. (2009)</p> <p>Integration of the largest possible number of people in the community into the alert system (Fakhruddin 2015; Mulyasari and Shaw 2013; Parker et al. 2009)</p>
<p>Population perception of warning system as something separate from public policies to ensure safety in the community, also observed by García (2012) warning systems for landslides</p>	<p>To develop and communicate a complete plan against landslides that goes beyond the warning system, including social measures involving police security</p>
<p>Fear of having the belongings stolen, similarly observed by Alam and Collins (2010) in Bangladesh in risk areas of cyclones</p>	

*Physical environmental issues*

<p>Selection of the safe places and the routes to them, also supported by Major and Atwood (2014)</p>	<p>Discussions with the population about the warning system elements related to the safe places and the routes to them (Parker et al. 2009), as well as constant monitoring of such elements (Nappi and Souza 2015)</p>
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*Cognitive beliefs, communication, and dissemination*

<p>Laziness and stubbornness among the local population perceived by community leaders; such superficial perception can hinder other more deep-seated factors related to the population characteristics that need to be further investigated, as discussed in Sect. 3.2</p>	<p>Further understanding about the different segments of population in risk areas to investigate the causes obfuscated by the perception of “laziness and stubbornness” indicated by the community leaders (as discussed in Sect. 3.2)</p> <p>Integration of the largest possible number of people in the community into the alert system (Fakhruddin 2015; Mulyasari and Shaw 2013; Parker et al. 2009)</p> <p>Develop messages according to the different population segments and constant and effective alert campaigns (as discussed in Sect. 3.1)</p>
<p>Need of improvement in the communication of the alarm, also discussed in Sect. 3.1</p>	<p>Invest in enhancing multiple and different channels to provide information that could ease the cost–benefit analysis (Dedieu 2009)</p> <p>Improve the communication channel between the government and the population, analyzing and integrating suggestions and complains (Parker et al. 2009)</p>

### 4.3.3 Interviews

#### **Function; Objectives**

Alerta Rio has a single objective, evacuating the community in case of high risk of landslides. However, it must be stated that the program is part of the planning cycle of Geo-Rio foundation, which also includes prevention, through structural measures, and monitoring. When asking the current program coordinator about these different parts of the cycle, she replies:

*“They are complementary, that is, it is impossible to carry out structural works everywhere, it is impossible for public management. As I said, disorderly occupation is a dynamic thing and it is very fast, and this disorderly occupation brings the risk of landslides in several points, it is impossible for the public manager to carry out structural measures everywhere, therefore, living together with the risk becomes real. How are you going to take care of these lives without structural measures? Monitoring ends up meeting this need and that's why it is having success”.*

As explained in the theory section, preparedness programs like Alerta Rio are about managing the consequences side of landslide risk. However, the consideration for focusing on either the hazard or the consequences, comes down to a cost-benefit analysis:

*“There are several factors that have to be analyzed, for example, there is a certain area that needs an intervention. We assess whether it is cheaper to carry out structural works on that site or remove the residents and place them in another area. Those who decide this are the GEOrio technicians. The choice is purely technical. The areas that include the largest number of people are analyzed, which will protect more people, because this type of work is expensive. So the public administration analyzes, when the work will protect many families. And in other places it is more expensive, so you have to either relocate people or, with lower risk, they depend on the alarm system”.*

However, whereas the program coordinator explains that structural measures are based on a ‘purely technical choice’, the president of the resident association (henceforth R.A.), which works together with Alerta Rio because of his function as community leader, thinks it is only about votes:

*“The big problem in Brazil is the political process, also in the issue of landslides [...] If we come up with a new project to present to them, they all know the importance of the cause, the reduction of problems and the lives that they could save, but all this they try to transform into votes ... their main evaluation point is: ‘the number of people living in the community’. It is an important point, but not all communities have the same problems, they all need help from the public authorities, but each has its specific needs [...] I had a project in 2013 and the Civil Defense came here, did the entire survey, stressed the importance of a project here due to the risk for residents, counted the number of homes - if there was one landslide how many families would be harmed with the possibility of victims and deaths, everything reported there was passed to the new municipal management, when there was a change of mayor, then they told us “we are out of funds, without money to do works”, but we found out that they did works in other communities, because they understood that in these communities there were political partners, that there was a certain cluster of votes there, and transferred the work that should be here to another community for the sake of votes.*

#### **Function; Capacity-Building**

When the program coordinator is asked about the critique of Bandeira et al. (2017) regarding Alerta Rio’s performance, she responds that especially a lack of capacity-building is to blame:

*“When the alarm system was implemented in 2011, there were much more frequent trainings and a lot of people adhered. There was a very good adherence also regarding evacuation: they would leave when they heard the alarm to go to the support points until the moment that they could return to the houses. But over the years, a little bit of credibility has been lost, people no longer want to go out so much, and nowadays many times the alarms go off but people do not go out. The reason for this is that when the alarm goes it does not mean that there will be a landslide, when the alarm rings it is because there is a high probability of mass movement. But the population sometimes thinks 'oh, I'm not going out, because nothing will happen'. And the system has lost some credibility over the years. How can we solve this? Encouraging more training, conversation with the population, with the community. The civil defense that is responsible for this and they try to do it, but today very little is done compared to what was done at the beginning of the project's implementation”.*

The community leader explains that the resident association has a great task in Alerta Rio, but without compensation:

*“I also want to emphasize that R.A. does not receive any money from the municipality, nor from the federal government. Who maintain the R.A. are the residents of the community, who are also not obliged to pay anything, so the R.A. survives with the collaboration of residents. “It is another flawed point of the government, if they have a project in partnership with the community and want to improve it, it would be their obligation to at least make a suitable place for the community”.*

### **Structure; Decision-Making**

One of the main problems of the low adherence to the alarm system, seems to be the division of responsibility. A noteworthy example are of course the support points, as communities are responsible for their own shelter when risk of landslides is high, whereas the community leader stated that there is not nearly enough space to house the whole community. However, this is not all, the coordinator of the civil defense also explains that Alerta Rio, although it claims to be the Community Alarm system, does not have any direct contact with the community:

*“The Rio Alert does not have a direct interaction with the community, this is done through the municipal civil defense or the Rio operations center, CORIO. CORIO concentrates all municipal agencies and some state agencies to manage the functioning of the city on a daily basis, and when the landslide disaster happens, for example, the entire structure of the operations center focuses on meeting this event. So Alerta Rio does not work directly with the community - it is represented in the communities by the Civil Defense or the Rio Operations Center”.*

The Alerta Rio coordinator also states that communication with the communities is the biggest point for improvement for the program:

*“I think that communication with communities that are at risk, of understanding what the work is and understanding of what we are issuing as a warning is the biggest point of improvement. In some way it is necessary to 'demystify' science, for closer cooperation. That is the point that we still need to work on. It is important for the community to understand what we are talking about”.*

However, more so than education or communication, the community leader thinks that shelter is most important to make evacuation possible, which is the responsibility of the government:

*“It is another flawed point of the government, if they have a project in partnership with the community and want to improve it, it would be their obligation to at least make a suitable place for the community”.*

He concludes that this is a recurring problem in governmental planning, as he also stated this to be the biggest flaw in NUDEC. He thinks both programs have much potential, which is often not fulfilled because long-term decision-making is missing.

### **Structure; Participation Interest**

The community leader thinks the adherence to the alarm is low, because it does not take many vulnerabilities of the community into account:

*“...for Alerta Rio there has to be an adequate support point for people, many people are at risk, 3 am, going out in the rain. [...] If I were [program] leader I would try to find out which places are the most suitable for support points, and there I would make the necessary improvements to become a NUDEC support point. Create an exclusive use site for the community to use in case of landslides”.*

The coordinator of NUDEC, that works with Alerta Rio as well, confirms that it is often too risky to go out when a storm is already happening:

*“People are afraid to leave the house and be robbed, or in some periods in the summer we have several rain alerts that end up not happening, so the alarm loses some credibility [...] Imagine a person leaving home in the rain, with children, at night and in danger of something happening, the ideal would be for us to have an accurate system that could sound the alert in advance so that people could leave their homes before nightfall and before the rain starts”.*

The infrastructure problem is twofold: it is dangerous to get to the shelter, and the shelter is too small to house the population. But besides the lack of proper shelter, the community leader mentions that landslide risk perception is low in the community. He states that the fear of being robbed is stronger than the risk of natural disasters:

*“The resident is more concerned with being robbed, with material goods than with life itself. I heard it from locals. ‘The world may fall and I won't leave my house’”.*

When asked if there are opportunities about increasing the participation to other activities of Geo-Rio, the manager responds that most tasks are too technical for the communities:

*“Identifying areas of risk is a role of Geo-Rio, but of course the population can make complaints, for example it realizes that it has a neighbor that is slope cutting [cutting the land can generate landslide risk], that person can make a report and ask us to carry out an inspection to identify this situation. But those who do the identification are the Geo-Rio technicians”.*

### **Performance; Vulnerability to Landslide Risk**

These different perspectives on the objectives result in conflict. For smaller communities, like the one of this community leader, it seems like the government offers them an alarm system so they do not have to provide structural measures. Although it makes sense to save the most people possible with the money available, from a governmental perspective, it results in the smaller communities feeling neglected. Especially because Alerta Rio is the only measure that takes these smaller communities into account, it should be done right, says the community leader. However, this is not the case because even though there is a smaller population, shelter is insufficient:

*“When it [the alarm] is triggered it means that you must go to a support point, which is usually a church or a resident association building, but not all associations have a suitable place to house a large group of people [...] For example, if there is a square, adapt it to become a support*

*point, or a football field. Our support points today are the R.A. building and a church. We have 3000 families within the community, imagine if they all become aware that it is necessary to leave their homes when the siren goes off, how do we house 3000 families in these places?"*

The Alerta Rio program manager, on the contrary, explains that the program produced great outcomes, specifically regarding the reduction in landslide casualties:

*"We understand the success of the system as the 'non-death of people'. From 2011 to 2018 we had a significant reduction in the number of landslide deaths. If you think about a city where we have extreme rains every year, a city with a very rugged topography and the occupation in an disorderly way, then when you can zero out the issue of landslide deaths for a few years, it shows the success of this management. We have historically reduced these deaths and we realize that this comes from the alert / alarm system, monitoring [risk mapping] and the structural works that the Geo-Rio foundation does".*

The performance of the program is directly related to the contribution of the program to the outcome. When asked if this reduction of landslide casualties was the result of the most logical contextual factor, a decrease of heavy rainfall events, she replies:

*"Last year, 2019, the rains were even stronger than that of 2010, but as I said, we had a lot of measures for containment works throughout most of the communities and this contributed to that even with a stronger rain the consequences were not so catastrophic for the city".*

## Discussion

### 5.1 Compatibility of Function and Structure

The DRR perception analysis of Schelchen et al. (2017) is the basis for the theoretical index; a set of related indicators that allow for systematic comparison across programs including opportunity for function, responsibility for structure and vulnerability for performance (Better Evaluation, 2020). These have been analyzed through indicators for each index, with participation interest and decision making power for structure, objectives and capacity-building for function, and changed disaster vulnerability for program performance. Only Alerta Rio fails to decrease vulnerability, while Mutirão Reflorestamento moreover increases opportunity and NUDEC additionally shifts responsibility.

*Tabel 4 - The theoretical index; a set of related indicators that allow for systematic comparison across programs, including opportunity, responsibility and vulnerability for program components function, structure & performance*

	<b>Participation &amp; Decision-making</b>	<b>Governance structure (Responsibility)</b>	<b>Objectives &amp; Capacity-Building</b>	<b>Function type (Opportunity)</b>	<b>Configuration Function &amp; Structure</b>	<b>Program Performance (Vulnerability)</b>
<b>Alerta Rio</b>	Efficiency, Community	Bottom-up	Evacuation, nonexistent	State objective	No Match	Poor alarm adherence
<b>Mutirão Reflorestamento</b>	Sustainability, Shared	Hybrid	Creating Jobs & technical and ecological skills	Shared objectives	Collaborative	Decreased risk vulnerability & increased job opportunities
<b>NUDEC</b>	Empowerment Shared	Hybrid	Creating risk communication & lifesaving first-aid skills	Shared objectives	Collaborative	Decreased risk vulnerability & increased responsibility

#### 5.1.1 Mutirão Reflorestamento

The policy review and the interviews about Mutirão Reflorestamento have shown that the project has been effective in fulfilling its objectives. The project has been successful in landslide prevention, it has substituted structural measures and therefore high costs for the municipality, generated jobs for the favelas and recovered and preserved an extensive amount of forest. The program has performing well in its many objectives, which is quite an accomplishment when considering the variety of objectives. According to the post-contingency approach, when pursuing many objectives, there has to be very participative interaction. This is certainly the case in the program, as there exist opportunities for life-long employment and the environmental agents have an important say in what happens in their community. So although the program has issues, this research could not relate them to the compatibility of function and structure. The biggest problems are political, with funding and investment being insufficient for optimal performance.

#### 5.1.2 NUDEC

The NUDEC program is the only program where participation was more than an means; where the community was involved with another objective than just ‘helping out’ the informal. The necessity of participation for the civil defense becomes clear when the coordinator of the program calls the community civil defense groups the ‘eyes and ears’ on the ground. This great appreciation is

translated to the great responsibility that the NUDEC's are given. This program is therefore the most 'participative' of all three, but with great responsibility there should also be great support, in the form of training, monitoring and continuous communication to make sure that the groups remain effective. Besides disaster response, the NUDEC's have a great task in keeping the community alert and are therefore indirectly contributing to the effectiveness of Alerta Rio.

5.1.3 Alerta Rio

Alerta Rio is the only program that does not have compatibility between function and structure along the lines of post-contingency planning. When the programs are placed in the post-contingency planning framework, see figure 14 below, it is noteworthy that Alerta Rio is the only program that does not have multiple objectives, but still opts for a participative governance structure. The structure that is applied is clearly an instrumental one, when looking at White's (1996) reasoning for instrumental participation: "to limit funders' input, draw on community contributions and make projects more cost-effective and as a means to achieving cost-effectiveness and local facilities". Cutting costs, however, has also cut the program's effectiveness, which makes the program not an instrumental program. It should either adopt more community objectives, aiming for a supportive approach, or take on the burdens of costs and infrastructure, aiming for an instrumental approach.

The post-contingency framework has its 'ideal' approaches along the complexity line, with right-bottom in the figure the 'supportive' approach, and left-top the 'instrumental approaches (Zuidema, 2016). Mutirão Reflorestamento and NUDEC are collaborative approaches, with the former leaning more to instrumental and the latter more to a supportive approach. Alerta Rio cannot be placed along the complexity line, because the single objective does not match the bottom-up structure. Post-contingency theory suggests that mismatch of function and structure in the Alerta Rio program could be the explanation for its poor performance, and that it should change either its structure or its function to increase its effectiveness.

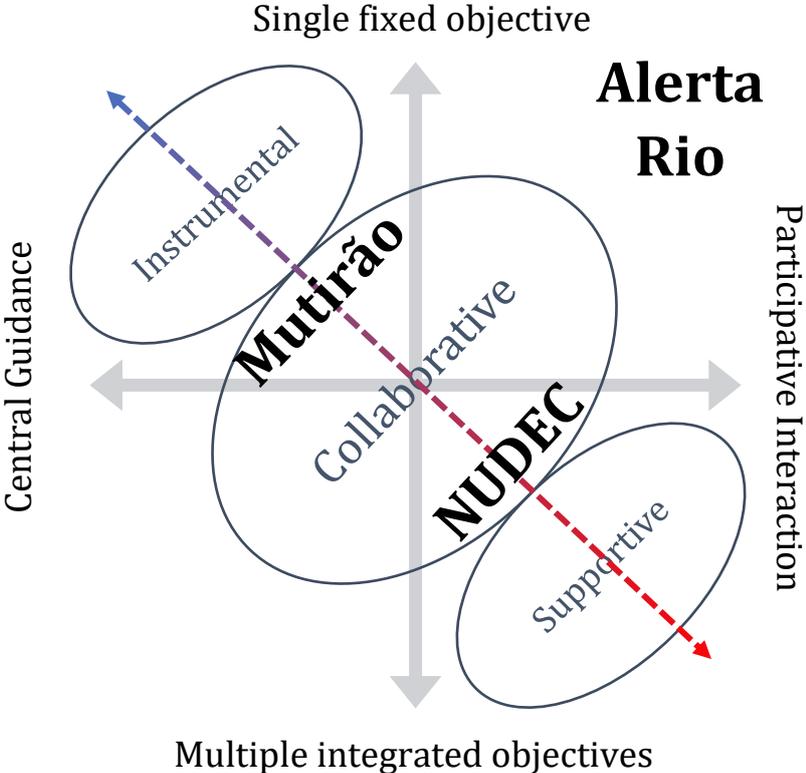


Figure 10 – CLRM programs filled in the post-contingency theory framework as configurations of function and structure.

## 5.2 Compatibility and Performance

### 5.2.1 Cross-case conclusions

Several forms of data collection point in the direction of poor performance of the Alerta Rio program. Although the program coordinator states that the program is responsible for the steep decline in landslide victims, it could very well be any or all other landslide risk reduction programs that should be attributed this impact. As previous research pointed out that the alarm system is not adhered to, and all three interviewees of this research confirmed this information, it is impossible to state that Alerta Rio is responsible for much of the landslide risk reduction over the years. The reason for the lack of community adherence has been attributed to many different problems. The research of Bandeira et al. (2017) names but a few, and this research found that lack of appropriate shelter and infrastructure, the lack of understanding of the system and the lack of trust in decisionmakers and politics are very important factors. Post-contingency theory suggests that the program should either adopt central guidance or community objectives to make it become effective. In practice, this would mean that the government would provide the appropriate infrastructure that is currently lacking (central guidance) or that the capacity-building is introduced through education, training and provision of resources so as to properly facilitate evacuation, as well as include objectives that benefit the community to ensure committed involvement, and not pseudo-participation (Freire, 1970). The other two programs show compatibility between function and structure, and although they can both be improved, the research has shown that they are indeed performing well. The programs have shared objectives which were successfully achieved through a hybrid governance form. This confirms the post-contingency theory, as the two programs that 'matched function and structure' were deemed successful in contrast to the one program that did not. What this means to the relation between compatibility and performance in CLRM in RJ is explained in the next section.

### 5.2.2 Theoretical feedback

The results seem to confirm the hypothesis of this thesis, that post-contingency theory is valuable for analysis of public participation, besides decentralization of government alone, as it might help explain successful performance of CLRM in RJ. However, there have to be made considerations, as the number of cases in this research is too low to allow for generalizations. Other factors, that Mutirão and NUDEC might have in common, might be more important for their successful performance than compatibility. In case that Alerta Rio was not deemed a 'successful' configuration, but did have successful performance, it could be suggested that other factors than compatibility are more important, which could then have been an interesting starting point for further research. Now, there should also be looked at similarities other than compatibility of the two successful programs. With these remarks at hand, still interesting indications were found for both the academic field and practice, and should stimulate further research applying a post-contingency theory to similar cases.

However, the findings resonate with the theory of Paulo Freire (1970) on critical pedagogy, which has as main message that only through collaborations between state (the oppressors) and informal communities (the oppressed) can tackle vulnerability, as this vulnerability is socially and politically constructed. Coates (2020) applies this specifically to disaster vulnerability, and states it is more important to teach the marginalized about the underlying causes of disaster risk, including inequal spatial planning and the consequent hazardous urbanization, than nudging behaviorist education like evacuation routes. These scholars as well as practitioners (Municipality of RJ, 2013; Nunes et al., 2020) recognize the importance of participation of communities in LRM to strengthen already existing DRR strategies (e.g. infrastructural mitigation) and develop new ones. There seems to be academic and practical consensus on the importance of community-state collaboration in LRM.

## 5.3 Policy lessons for CLRM in RJ

### 5.3.1 Success factors

As mentioned in the previous section, no determining conclusions can be drawn for the relation between function and structure compatibility, and performance. But important indications were found that support the theory, which will be stated and can be tested in further research. An interesting factor for success was found through the matching of patterns across cases. The community has proven to be willing and able to undertake important tasks for landslide risk reduction. This became maybe most evident by the NUDEC program. Although the participants do not receive payment, not even proper infrastructure and training for that matter, the community leader explained that there were still 60 people that volunteered and nowadays provide the governmental emergency services with vital information on the ground. The reforestation program showed similar results, with the participants showing very technical knowledge on landslide risk reduction, and showing the willingness to obtain even more knowledge and responsibility. Even in the Alerta Rio program, the community leader states that he wants more responsibility to help to improve the program:

*“Of course, we in the community need to do our part too, but we take this knowledge to the public authorities and they are always wanting to know 'Which politicians own this area?’*

### 5.3.2 Fail factors

A returning fail factor throughout the cases is investment. Although the willingness and ability of community participation for the programs have become evident through this research, the administration of the municipality fails to recognize and support it. The civil defense coordinator states:

*“2016 it was the last year that I worked well with NUDECS, with a good structure. Then the administration changed and the program changed for the worse”.*

This is in essence a political problem, Especially because within the disaster risk reduction cycle there is often a focus on the action after the event, as cited by the UN director of DRR: (UN office for DRR, 2020), when there is attention from the media and there are votes to be collected. Even the coordinator of the prevention program of this research, Mutirão Reflorestamento, states he is too occupied with ex-post rather than ex-ante DRR work:

*“The city, citizens and public authorities, have to plan ahead. You have to have planning and execute the planning, because if we just continue to keep putting out the fire, LRM won't work”*

Another recurring problem is continuation of programs, which has proved a problem in all three programs. For Mutirão Reflorestamento, there is a lack of participants, not because there are not enough people that want the job, but because of the deficient resources. This makes the program having to focus on conserving the area recovered, but unable to reforest further. And there are ambitious plans to connect all the existing forest fragments in the city, so there is enough work to be done. For NUDEC there is a lack of communication between government and communities, which hinders the monitoring of development, awareness, and outcomes, and consequently hinders improving the performance of existing community civil defense groups For Alerta Rio, the lack of continuation is most evident, as subsequent steps have been absent since its implementation.

### 5.3.3 Recommendations to improve performance

#### Compatibility

This section will mainly be based on Alerta Rio, as this program has naturally the most room for improvement regarding compatibility of function and structure. It is cases of failed decentralization like these that made Zuidema to think about post-contingency planning in the first place (2016, p. 8):

*“... it seemed evident that the success of decentralization operations would be conditioned by the circumstances encountered; i.e. not every issue or task seemed well suited for decentralized working. It was within this context that I again was drawn to the contingency argument” .*

It is therefore interesting to look at the low impact of Alerta Rio to establish well-considered recommendations, as this is the origin of the theory of post-contingency approach. Although inappropriate decentralization is often the cause for ineffective planning, it does not mean that reversing the process is the best answer. Different approaches can be chosen to restore the effectiveness of the program, to realize different kinds of objectives and have a greater impact:

*“Post-contingency takes into account that different approaches are known to have alternative benefits (consequences) that we might value regardless of the exact situation we face. So you could base your decision on the context or the desired outcome. These two choices relate to on the one hand the functional ambition of our approach (i.e. what do we mean to achieve) and, on the other hand, the structural configuration of our approach (i.e. the allocation of power, influence and responsibilities between various actors). The performance of an approach depends on the degree to which function and structure match” (Zuidema, 2016, p. 95).*

Exactly in line with the purpose of the post-contingency approach, two opposing recommendations will be given, that could both improve effectiveness but in different ways. One is based on returning to a ‘certain’ planning approach. Currently, the community is responsible for the shelter themselves, using existing infrastructure. This research has shown that better infrastructure is necessary, in the first place to provide sufficient space, and secondly for the community to be able to reach the shelter safely. As explained by both the community leader and the program coordinator, it makes no sense to install a sophisticated alarm system, only for people not able to get to safety when the alarm goes off. Therefore, more government interference can be recommended to take responsibility for the shelter, and make ends meet. This entails a more centrally guided approach.

The other recommendation for Alerta Rio is adopting a more ‘flexible’ planning approach. The definition of *governance* of Zuidema (2016, p. 22) is: *“a more fluid sharing of competences between formal governments and what is called the ‘civil society”*. The civil society in the favelas is as competent as any, because of their long neglect by urban planning and governmental services, which has made them capable of many complex tasks. Landslide risk management might be the most complex of them all, and this research has indicated that the favelas are very willing, but not always able to take on this responsibility. It is thus possible to include civil society in the landslide risk management of RJ, when they are properly supported. Thus, if chosen for this flexible planning approach, it is strongly recommended to assist them better in ways of communication, training and funding. If people gain a better understanding of landslide risk, they will adhere to the system, as stated by interviewees from Geo-Rio, civil defense and the community alike. After all, the community adhered to the system just after the landslides of 2011, when perceptions of disaster risk were very high. But there should not have to be another major disaster, to raise the community’s awareness. Better capacity-building can be the alternative to make Alerta Rio effective again.

## Communication

Although many fail factors can be identified, e.g. a decision-making power, capacity-building, investment, and continuity, the data analysis reveals that poor communication is cause of most problems analyzed in this research. Therefore, it is recommended to improve communication.

All the programs lack continuation, either because of a lack of investment (NUDEC & Mutirão) or proper support (Alerta Rio). For the former, better communication between community and government would mean that trainings can be continued and results and essential information become known. For the latter, capacity-building should be added in the shape of education on landslide risk and the alarm system, and the community should be given more decision-making power in the program, so as to include community objectives other than evacuation. At the moment, there are contrasting views on the program's planning process. Whereas Geo-Rio explains that structural measures take place in the most populated areas because that means the most landslide risk is reduced, the community perceives it as if the government only wants to secure votes. The data analysis of this research shows that there is an absence of communication between the community and Geo-Rio within the program, which results in low adherence. Whatever approach is adopted for the program, it is thus imminent that new channels of communication between state and community comes to exist.

Investment is in essence a political issue, but it is important to make success of the programs evident to increase recognition, support and subsequently investment. As was explained in the theory section of this thesis, the current changes in LRM are highly uncertain, and results are needed to push and pull this collaborative turn over the edge (Loorbach & Rotmans, 2015). The danger now, is not the absence of results, but that results are not recognized. At the moment, collaborative practice is ahead of the decisionmakers & politics, but it will need its support to keep performing as it has been. However, when the coordinator of the civil defense spoke about this issue, it became clear that in order to establish this, first communication between governmental bodies responsible for LRM should improve significantly. He states:

*“if the city is unable to solve the problem with its own resources, it will need state and federal resources [...] This report sent to the federal government is made by the civil defense based on information received from each secretary of the city hall. But we often do not receive the information necessary to obtain the city's resources. This is because in many cases the manager of the secretariat for political or corruption reasons, keeps this information for him and does not pass it on to us”.*

It is thus necessary to improve the communication between practice and politics, between lower and higher governments, between the departments within the municipality, and between the community and the government, in order to improve the performance of LRM in RJ. For the latter, lessons can be drawn from Paulo Freire's pedagogy of the oppressed:

*“Cooperation [...] can only be achieved through communication. Dialogue, as essential communication, must underlie any cooperation. [...] Dialogue does not impose, does not manipulate, does not domesticate, does not “sloganize”. This does not mean, however, that dialogical action leads nowhere, [...] nor that the dialogical human does not have a clear idea of the objectives to which she is committed” (1970, p. 141).*

Freire (1970) states that dialogue, meaning mutual recognition and willingness to learn from each other, is the basis of effective collaboration, as it creates objectives, either single or multiple, with ownership of both parties. The poor performance of Alerta Rio shows the danger of imposed objectives, as the task of evacuation was transferred without dialogue and proved too difficult.

## Conclusion

This research has looked into the three biggest programs with collaboration between state and community in landslide risk management in Rio de Janeiro, from a post-contingency approach. Although none of the programs under study proved to be perfect, and some of them even far from it, results show that decentralization was very effective in the programs Mutirão Reflorestamento and NUDEC. This research aims to showcase their performance and promising results for the world and especially the RJ government to sustain their success. Recently, the performance of NUDEC has gone in decline, which could possibly reverse the collaborative turn of LRM, while it has brought many benefits to informal communities in RJ. Communication between community and government is believed to be key to prevent this from happening (Loorbach & Rotmans, 2005).

While Mutirão Reflorestamento and NUDEC can both be improved, only Alerta Rio has proven to be performing poorly and not to be compatible in its function and structure. The results indicate that there should be a fundamental change, either in functional strategy or governance structure, to improve its performance. By adopting community objectives and capacity-building, a flexible approach can be obtained where communities understand the system better. But it could also be stated that decentralization should not have happened in the first place, as constraints to the ability for communities to undertake this task have proven to be too great. Returning responsibility and investments back to central guidance could ensure more effective evacuation. The choice between these two approaches should be made on the desired objectives: more opportunities, responsibilities and therefore development of the favelas, or more certainty in reaching its main objective of effective evacuation.

The aim of this research was not to generalize, but to create a hard-to-summarize research that offers concrete context-dependent knowledge for post-contingency theory. The findings indicate that compatibility of functional strategy and governance structure is related to the performance of collaborative landslide risk management in the municipality of Rio de Janeiro. While there is much willingness of the community to participate, there are limitations to their abilities to do so, and capacity-building is necessary for this obstacle to be overcome. Funding for collaborative programs was low under the administration at the time of study, but the municipal administration has changed on the 1<sup>st</sup> of January of 2021, which could turn the tide and allow for improvement.

It is not possible to conclude after this research that CLRM is only successful when there is compatibility between function and structure, but there are strong indications that this link indeed exists. It is also noteworthy that a rain event in 2019 stronger than that of 2010 did not result in casualties. It is important to look into the relation between the reduced landslide disasters and the collaborative turn that has taken place in landslide risk management since 2011. The research included only a small amount of cases, and it is only through further research that a stronger claim can be made for the relevance of a post-contingency approach to collaborative landslide risk management in Rio de Janeiro, Brazil. This research has looked into the three biggest CLRM programs in RJ, and no other CLRM programs of similar size have been found for the same context. However, there could be looked into CLRM programs in other cities or collaborative programs in other branches of government, like flood risk and environmental management. São Paulo would be a logical option, as it is home to the same mountain range and to collaborative programs of similar size as the ones in RJ. The results of this research can furthermore be taken into account, not replicated, for different practices and different contexts (Mukhtarov, 2014).

## Reflection

In this chapter I will reflect on my progress as a researcher through the process of this thesis and the EIP program as a whole. The biggest limitation of the research is that I was not able to see the programs and their activities with my own eyes, and speak with the people involved face to face. The pandemic resulted in interviews in an online setting and of a limited amount, which adversely affected the research because of their subjective nature. Even though they are put against the other two forms of data gathering of the policy review and previous research, a greater number of interviews would have provided results that are closer to reality. The pandemic changed the environment for me as a student, but the situation in Brazil at time of research made it especially impossible to conduct research in the field. This was beforehand an important matter to me, as I believed that witnessing such practical programs would have been essential in understanding them. Although I could not realize this plan, I learned how to be flexible as a researcher, as well as how to conduct research under such abnormal circumstances. I do hope to visit the programs in the future, so as to evaluate and complement the knowledge that I required through this research.

I first encountered the research topic of this thesis in my bachelor program, International Land- and Water management, at the Wageningen University. This program had mentioned the importance of collaborative management, but had never explicitly conceptualized collaborative planning. The EIP program addresses the theoretical background of collaborative planning in great detail and from various standpoints. This has improved my knowledge on the matter significantly. The balance of technocratic and collaborative approaches is a red thread through the EIP program. My bachelor program focusses more on technical aspects of similar problems, and I feel that the EIP program is greatly compatible, as it complements the planning side of technical issues. A great example was a lecture on the failure of the Dutch government to introduce adaptive water management approaches in the Mekong Delta. I learned that power and politics stopped the plans from being realized, while in I was taught in Wageningen how effective the proposed plans were, but not why they were not introduced. The EIP program has made me able to zoom out from planning or management situations, and relate local and wider institutional contexts. It was important to follow two programs that look at the same management / planning issues but through different lenses, so as to balance my views on practice and theory as a researcher. I feel that I found a better balance between academic and societal relevance in this particular research. The theory-testing was equally important as the practice of landslide risk management itself, whereas in my bachelor thesis, my focus was mainly on recommendations for practice, without much theoretical feedback.

I enjoyed and learned a lot from the qualitative methodology of this thesis, as I only used quantitative research methods before. However, I am aware that there is also more subjectivity in this way of doing research. I tried to minimize this subjectivity with data triangulation and also by following the methodology of Yin (2014) rigorously, to ensure internal and external research validity. However, I have learned that it is nearly impossible for a qualitative research to be truly objective, as the researcher's world view is more present than with quantitative research. Nonetheless, I feel that the 'soft' qualitative research methods have given me more insights and a better understanding of my topic than the quantitative research methods have given me about my last research. The greatest lesson for me as an academic that I gained from this research, and of EIP overall, is the better understanding of the benefits and limitations within spatial planning; of the technical and the communicative rational; of engaging society in spatial- and management transformations; and of qualitative and quantitative research methods. I now feel better equipped to balance the pros and cons for these dilemmas and make better situation specific recommendations and decisions.

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# Appendix A: Relevant LRM institutions in Rio de Janeiro

## Appendix A1 - Responsible institutions during heavy rain events

Tabel 5 - (Nunes et al., 2019)

Matrix Name	Version	Operational Stage	Last update	RESPONSIBLE ORGANIZATIONS AND PARTICIPANTS														
<b>STRONG AND / OR LONG RAINS IN THE CITY</b> <i>ACTIVITIES OF THE MAIN INSTITUTIONS WITH DIRECT ATRIBUTIONS IN THE IMINENCE AND DURING THE RAIN</i>	14/11/17 (version)			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	<b>ACTIVITIES AND THEIR RESPONSIBLES OR PARTICIPANTS</b>																	
				SUBPDEC (Civil Defense)	COR (Emerg. Oper. Center)	CBMERU (Fire Depart.)	GM (Municipal Guard)	CET-RIO (Traffic Eng. Co.)	COMLURB (Mun. Clean. Co.)	RIOLUZ (Public Energy Co.)	CONSERVAÇÃO (U. Conservation)	ALERTA RIO (Mun. Alarm System)	GEO RIO (Geol. Found.)	RIO ÁGUAS (Found. Waters Rio)	SMAS (Secre. of Social Welfare)	PUBLIC SERVICES CONC.	PUBLIC TRANSPORT CONC.	SMS (Health's Secr.)
MOBILIZATION	1	Maintain emergency warning / preparedness.	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
	2	Maintain available and updated communication channels with SUBPDEC, as well as send (when requested) representative for COR.	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
	3	Act (informe and mobilize), according to the protocol of changes of Operational Stages, the responsible organs.	R	MR	F	F	F	F	F	F	F	F	F	F	F	F	F	F
CONDITIONS OF RAINS	4	Monitor the weather conditions and update Alerta Rio System.	F	F								MR						
	5	Activate Alerta Rio and Community Alarm (sending of SMS and activation of sirens), inform all institutions belonging to Civil Defense System.	MR	F								R						
	6	Assess the risk and/or occurrence of slope slides.	R	F								R	MR					
	7	Monitor and evaluate the risk and/or occurrence of flooding of rivers, including, if necessary, participating in the operation of floodgates.	F	R								F		MR				
DRAINAGE	8	Monitor and evaluate the occurrence of floods.	F	R		F	F				R	F	MR					
	9	Clean and unclog drains and sewers.							MR		R		F					
	10	Clearing the micro drainage system.							F		MR		F					
TRAFFIC	11	Carry out cleaning and/or clearing of roads.		F			F	MR			F							
	12	Monitor and control vehicle traffic and establish, if necessary, alternative transit routes.		F			MR											
	13	Adapt the mass transport system.		F														MR
	14	Keep population and other bodies informed about traffic conditions, including variable message boards.	F	R			MR											
GLOBAL SECURITY	15	To solve or to minimize the effects of the occurrence of slope slides.	R	F	R							MR		R				F
	16	Acting in civil protection.	MR	F	F	R									F			
	17	Ensuring the order and safety of services.	F	F	MR													
RESCUE	18	Acting in search and rescue operations.	F	F	MR	F				F								F
	19	Carry out screening and/or first aid actions.	F	MR														R
	20	Carry out shoring actions and/or emergency demolitions.	R	F	F				F		MR							
OPERATIONAL AID	21	Provide emergency lighting.	F	F						MR								R
	22	Modifying, disrupting or restoring the provision of essential services (water, electricity and gas) in order to minimize problems, avoid accidents or assist the services.		F						F							MR	
	23	Isolate and/or interdict the affected area.	MR	F	R	R												
	24	Provide machines and equipment, with operators when necessary, for the execution of the services.	R	F		R			R	R	R		R	R	F	F		
HEALTH/SOCIAL ASSIST	25	Identify and/or support the affected population, as well as set up and manage temporary shelters.	R									F		MR				
	26	Inserted affected population into social benefits.	F											MR				
	27	Accounting for the dead and wounded.	MR	R	R													R
	28	Monitor and adapt capacity of the emergency.		F														MR
INTEGRATION	29	Articulate actions and information among the agencies present on site.	MR	F	F													
	30	Guide and inform the population through the media.	F	MR	F	F	F	F	F	F	F	F	F	F	F	F	F	A
	31	Coordinate the triggering of resources.	F	MR														

MR - MAIN RESPONSABLE

R - RESPONSABLE F - FOLLOW AND/OR SUPPORT

Appendix A2 - Responsible institutions during normal and emergency periods of normality emergency

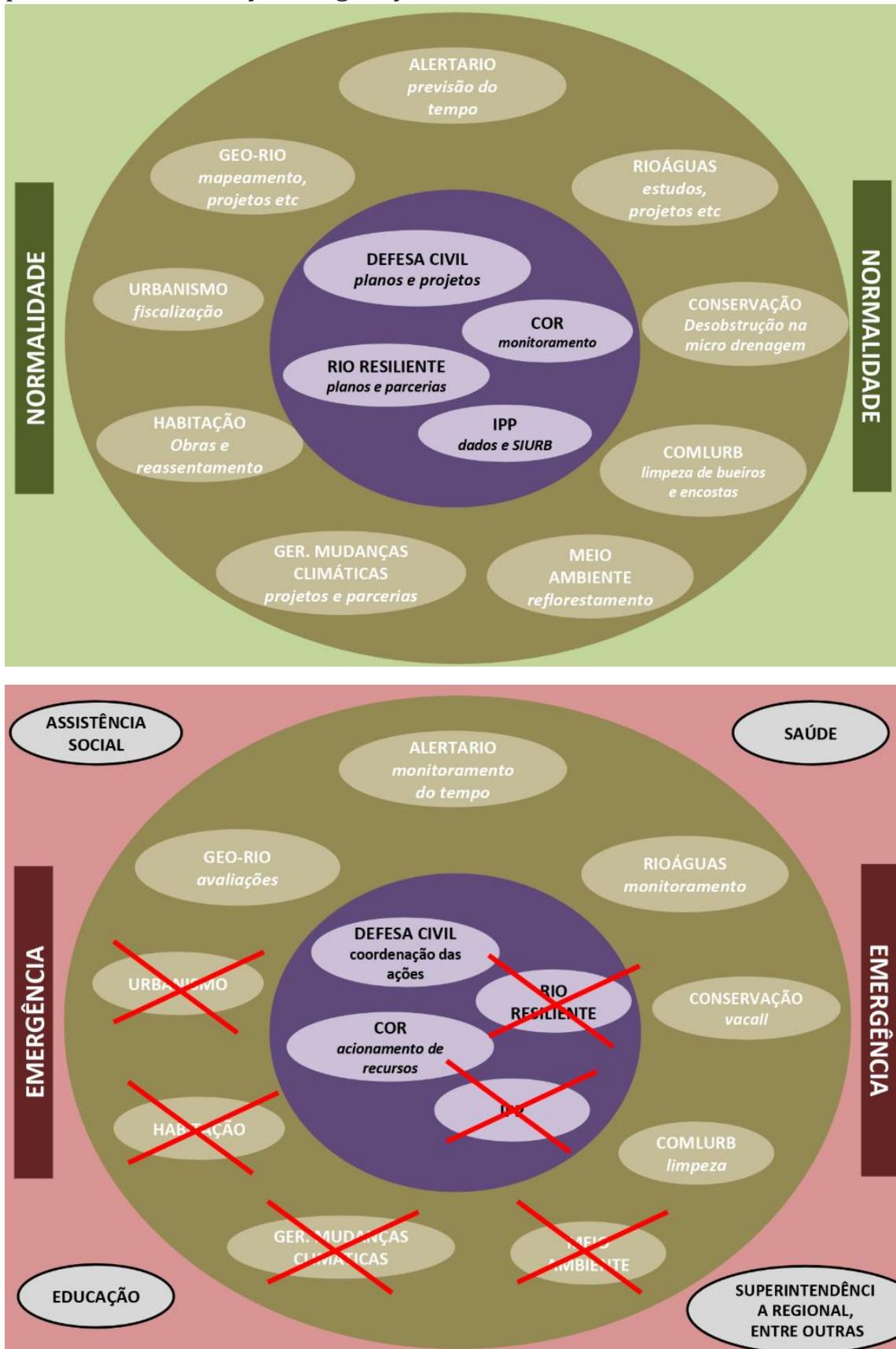


Figure 11 - Provided by A. Moraes, 2020

## Appendix B: Policies under review

Program	Documents
Mutirão Reflorestamento	<p><b>Municipality of RJ</b> (2015) – Conservation Plan for the Mata Atlantica forest</p> <p><b>SMAC</b> (2019) - 33 ANOS PLANTANDO FLORESTAS NO RIO DE JANEIRO</p> <p><b>SMAC</b> (2020) - Programa de Reflorestamento. Retrieved from:  <a href="http://www.rio.rj.gov.br/web/smac/recuperacao-ambiental">http://www.rio.rj.gov.br/web/smac/recuperacao-ambiental</a></p>
NUDEC	<p><b>Defesa Civil</b> (2013) - PROGRAMA DE PROTEÇÃO COMUNITÁRIA – ADAPTAÇÃO AOS RISCOS DE DESASTRES NA CIDADE DO RIO DE JANEIRO</p> <p><b>Defesa Civil</b> (2017) NÚCLEO DE RESILIÊNCIA COMUNITÁRIA</p> <p><b>Defesa Civil</b> (2017) - VOLUNTARIADO EM DEFESA CIVIL</p>
Alerta Rio	<p><b>Geo-Rio</b> (2010, 2011, 2012, 2013, 2014, 2015) - Relatório Sintético de Estatísticas para os Escorregamentos na Cidade do Rio de Janeiro</p> <p><b>Defesa Civil</b> (2017) - Plano de Contingência</p> <p><b>Geo-Rio</b> (2020) – História de Geo-Rio</p>

## Appendix C: Semi-structured interviews

### Appendix C1 – Interview guide

<b>Participation</b>	<b>Initial Questions</b>	<b>Follow up Questions</b>
<b>Vulnerability</b>	What are the greatest hazards to your community? How did you deal with these hazards before the project? Has the project changed the vulnerability of community?	Why do you think this is the greatest hazard? Did you consider moving to a safer place? How did vulnerability change after the project and why?
<b>Opportunity</b>	To what extent are conditions for effective participation met? Did the community obtain new skills? Are you satisfied with the opportunities offered? Is participation effective?	What kind of skills? Are opportunities fairly distributed among the community? Have employment opportunities increased?
<b>Responsibility</b>	Who participates, and in what way? What are their motives? Who should be responsible for dealing with landslide risk? What is your motive for participating in the project?	Why the community/ government and not the other party? Should you be awarded for taking on the responsibility? Would you be willing to take more responsibility?

<b>Function</b>	<b>Initial Questions</b>	<b>Follow up Questions</b>
<b>Objectives</b>	What were the main objectives of the program?	What would have happened without the intervention?
<b>Outcomes</b>	Has the intervention made a difference? How has the intervention made a difference?	How and why have the impacts come about? What causes have resulted in the impacts? Were there unintended impacts?
<b>Effectiveness</b>	To what extent can an impact be attributed to the intervention? Was the intervention needed to produce the effect?	What is the net effect of the intervention? For whom has the intervention made a difference?

## Appendix C2 - Overview interviewees

<b>NAME</b>	<b>INTERVIEW DATE</b>	<b>ORGANIZATION / GROUP</b>	<b>PROJECT</b>	<b>FUNCTION</b>
<b>CELSO JUNIUS</b>	1/6/2020	SMAC	Mutirão Reflorestamento	Program founder
<b>LUIZ LOURENÇO</b>	3/6/2020	SMAC	Mutirão Reflorestamento	Program manager
<b>AIRTON MORAES</b>	10/6/2020	Defesa Civil	NUDEC	NUDEC coordinator
<b>CARLOS</b>	12/6/2020	Community Member	Mutirão Reflorestamento	Environmental agent
<b>NOCA DIVINEIA</b>	13/6/2020	Community Member	Mutirão Reflorestamento	Environmental agent
<b>RAQUEL FONSECA</b>	18/6/2020	Geo-Rio	Alerta Rio	Alerta Rio coordinator
<b>CLAYTON PAIXÃO</b>	24/6/2020	Community Leader	NUDEC & Alerta Rio	President of resident association