Applying Disaster Risk Governance in Dynamic Environments

Case study Rio de Janeiro State, Brazil

Dissertation

zur

Erlangung des Doktorgrades (Dr.rer.nat.)

der

Mathematisch-Naturwissenschaftlichen Fakultät

der

Rheinischen Friedrich-Wilhelms-Universität Bonn

Vorgelegt von

Alicia BUSTILLOS ARDAYA

aus

Cochabamba, Bolivien

Bonn, November 2019

Angefertigt mit Genehmigung der Mathematisch-Naturwissenschaftlichen Fakultät der Rheinischen Friedrich-Wilhelms-Universität Bonn

1. Gutachterin: Prof. Dr. Mariele Evers, Geographisches Institut, Bonn University

2. Gutachter: Dr. Udo Nehren, Institute for Technology in the Tropics and Subtropics, TH Köln

Einreichungsdatum: 19.11.2019

Tag der Promotion: 26.05.2020

Erscheinungsjahr: 2021

Publikationen

Diese Dissertationsschrift, ist kumulativ angelegt.

Die folgenden Publikationen sind Teil der Dissertationsschrift:

1. **Bustillos Ardaya, A**., Evers, M., and Ribbe, L.: What influences disaster risk perception?: Intervention measures, flood and landslide risk perception of the population living in flood risk areas in Rio de Janeiro state, Brazil, International Journal of Disaster Risk Reduction, doi:10.1016/j.ijdrr.2017.09.006, 2017. **(chapter 4).**

2. **Bustillos Ardaya, A**., Evers, M., and Ribbe, Integrated Participatory Methodologies for Disaster Risk Reduction: Tools to Analyze Complex Systems Through Participatory Processes in Brazil, book chapter, Strategies and tools for a sustainable rural Rio de Janeiro, Springer series on environmental management, Springer, Cham, Switzerland, 1 online resource (xxxii, 513 https://doi.org/10.1007/978-3-319-89644-1_23, 2019. **(chapter 3).**

3. **Bustillos Ardaya, A**., Evers, M., and Ribbe, L., Participatory approaches for disaster risk governance? Exploring participatory mechanisms and mapping to close the communication gap between population living in flood risk areas and authorities in Nova Friburgo Municipality, RJ, Brazil, Land Use Policy, 88 p 104103 doi: 10.1016/j.landusepol.2019.104103 **(chapter 5).**

Die folgende Präsentation ist Teil der Dissertationsschrift:

1. **Bustillos Ardaya A**., Cho M., Miranda Arana J., Global umbrella for local rains, assessing implementation of the Hyogo Framework for Action in Rio de Janeiro, Brazil. World Water Week 2015 presentation. SIWI Stockholm International Water Institute, Workshop: Managing change - strengthening resilience to climate and disaster risks. **(chapter 2).**

Zusammenfassung

Zwischen 1980 und 2015 starben rund 1,6 Milliarden Menschen bei meteorologischen, geophysikalischen, hydrologischen oder klimatologischen Katastrophen. Die zukünftigen jährlichen Verluste werden auf 314 Milliarden US-Dollar allein in der bebauten Umwelt geschätzt. Die Zahl der weltweit relevanten Naturschadenereignisse hat sich in den letzten 30 Jahren mehr als verdoppelt, was zu Todesfällen, Schäden an der Infrastruktur und negativen Auswirkungen auf die Wirtschaft führte. Staatliche und nichtstaatliche Institutionen haben begonnen, in die Katastrophenvorsorge zu investieren, einige von ihnen im Einklang mit internationalen Rahmenbedingungen wie dem Hyogo-Aktionsplan (2005-2015) oder dem Sendai-Rahmen (2015-2030). Angesichts der großen klimatischen Veränderungen, die die Gesellschaft herausfordern, sowie der gesellschaftspolitischen Veränderungen scheint die Katastrophenvorsorge eine offensichtliche Priorität für weltweit Regierungsführungen zu sein haben, doch scheint dies ein Thema zu sein, das nicht oft auf der Agenda der Regierungen steht. Während sich die Literatur tendenziell auf die Substanz der Katastrophenrisikominderung konzentriert hat, gibt es wenig Forschung über das Erlernen von Design, Anwendung und Operationalisierung von Katastrophenrisikomanagement. Die meisten Fallstudien in der Literatur stammen aus Ländern des globalen Nordens, in denen die Systeme gut etabliert sind, Informationen reichlich vorhanden sind und die Kommunikationsnetze stark sind. Regionen mit dynamischem Umfeld, in denen sich die gesellschaftspolitischen und wirtschaftlichen Systeme ständig ändern und Informationen nicht zugänglich sind, können einen neuen Ansatz und spezifische Fälle erfordern, um Änderungen, Anpassungen und Ergänzungen bestehender Konzepte der Katastrophenvorsorge zu unterstützen.

Aber **Wie werden bestehende Konzepte der Katastrophenvorsorge in potenzielle und angewandte Ansätze für den Umgang mit dynamischen Umgebungen im Rahmen der Katastrophenvorsorge umgesetzt?** Mit der Definition des Katastrophenrisikos durch die Internationale Strategie der Vereinten Nationen für die Katastrophenvorsorge (UNISDR) und das Intergovernmental Panel on Climate Change (IPCC) sowie dem Rahmenwerk des International Risk Governance Council (IRGC) für die Risikobewältigung bewertet dieses Dokument die Katastrophenvorsorge mit einem interdisziplinären Ansatz in einem konkreten Fall. Der Kern der Fallstudie ist der Staat Rio de Janeiro, einer der dynamischsten Staaten Brasiliens in Bezug auf Bevölkerung und Wirtschaftswachstum, der von Überschwemmungen, Dürren und Erdrutschen betroffen ist. Anhand von 391 quantitativen Fragebögen, 26 semi-strukturierten qualitativen Interviews, 11 Fokusgruppen und 3 Workshops sowie Sekundärdaten und Teilnehmerbeobachtungen werden die institutionelle Ordnung des Staates, die Wahrnehmung der in den Risikogebieten von Nova Friburgo - einer der am stärksten betroffenen Gemeinden im Jahr 2011 - lebenden Bevölkerung, die von den beteiligten Institutionen implementierten partizipativen Mechanismen sowie das Verhältnis von Kommunikation und Macht zwischen öffentlicher Macht und Zivilgesellschaft aufgezeigt.

Die Hauptfaktoren für die Steuerung von Katastrophenrisiken nach der peer-reviewten Literatur werden durch eine quantitative Literaturüberprüfungsmethode untersucht und priorisiert. Diese Faktoren, ergänzt durch Sekundärdaten und eine integrierte partizipative Methodik, bilden die Grundlage für die Feldforschung im Bundesstaat Rio de Janeiro. Die Wahrnehmungen der lokalen Bevölkerung in den Risikogebieten der Gemeinde Nova Friburgo und ihre Haupteinflüsse werden

durch deskriptive Statistiken, Faktorenanalysen und Regressionen der Umfrageergebnisse aufgezeigt. Die Partizipation wird in institutionellen Prozessen durch Interviews und durch die Anwendung des Fung'schen Beteiligungsdreiecks bestimmt. Die soliden Ergebnisse der partizipativen Kartierung auf verschiedenen Ebenen werden gemessen und verglichen, um angewandte und potenzielle Wege zur Katastrophenrisikominderung zu erkunden. Governance, Kommunikation und Machtverbindungen werden schließlich in drei Workshops und allen zuvor beschriebenen Prozessen analysiert.

Bei der Katastrophenvorsorge haben öffentliche Macht und Zivilgesellschaft unterschiedliche Interessen, und eine vollständige Win-Win-Situation ist sehr unwahrscheinlich. Die Entscheidungsfindung in Risk Governance Prozessen muss sich mit Kompromissen auseinandersetzen, die von allen Beteiligten verstanden und berücksichtigt werden müssen. Faktoren wie mangelndes Vertrauen, Fehlkommunikation und negative Wahrnehmung sind besonders schwer anzugehen und können nicht vollständig eliminiert, werden, können aber erheblich reduziert werden. Staatliche Institutionen, die in einem meist top-down, zentralisierten System, das die Teilnahme nicht erzwingt, für Katastrophenrisiken arbeiten, schaffen Polarisierung, Misstrauen und nur wenige Kommunikations- und Treffpunkte zwischen Zivilgesellschaft und öffentlicher Macht. Abrupte Veränderungen des Top-Down-Systems wirken sich nicht mit gleicher Geschwindigkeit auf die organisierte Zivilgesellschaft aus. Während die Folgen von Veränderungen für die öffentliche Macht unmittelbar sind (Budgetkürzungen, Struktur-veränderungen und Positionsveränderungen), wird sich die Zivilgesellschaft langfristig nur langsam verändern. Auch wenn zukünftige Veränderungen in der Regierung diese Prozesse in andere Richtungen stark beeinflussen, sollten die Netzwerke stärker werden und dynamisch bleiben.

Das Gefühl der Vernachlässigung dieser Kompromisse in der in Risikogebieten lebenden Bevölkerung erfordert ein Verständnis der Komplexität und der beteiligten Akteure, damit sie sich anerkannt fühlen. Eine klare Kommunikation darüber, wie die Entscheidungen getroffen werden, und die Möglichkeit, an diesen Entscheidungen teilzunehmen, sollte eine Schlüsselkomponente und ein Ausgangspunkt für eine bessere Risikoverwaltung sein, gefolgt von der Kontinuität dieser Prozesse zur Verbesserung der Wahrnehmung und des Vertrauens. Damit die Gesellschaften von den ständigen Veränderungen profitieren und gleichzeitig die negativen Folgen der damit verbundenen Risiken vermeiden können, wie die IRGC bekräftigt, bedarf es des Zusammenhalts der verschiedenen Beteiligten. Die Umsetzung von Beispielen, wie sie in der Fallstudie vorgestellt wurden, in größerem Umfang wird erhebliche Anstrengungen, Zeit und Ressourceninvestitionen erfordern. Dieser spezifische Fall kann auch zur Verbesserung der Beurteilung, Kommunikation und des Managements in umliegenden Gebieten und ähnlichen Fällen in Randgebieten mit schnellem Wachstum und hoher Dynamik genutzt werden. Angesichts der prognostizierten größeren und stärkeren Veränderungen ist und bleibt die Kontinuität (ein Schlüsselfaktor aller Governance-Prozesse) eine echte Herausforderung in Brasilien, die physischen und temporären Raum auf der Agenda aller Beteiligten erfordert.

Summary

Between 1980 and 2015, around 1.6 billion people were killed in meteorological, geophysical, hydrological or climatological disasters. Future annual losses are estimated to reach US$314 billion in the built environment alone. The number of relevant natural loss events worldwide has more than doubled in the last 30 years, causing loss of lives, damage to infrastructure, and a negative impact on the economy. Governmental and non-governmental institutions have started to invest in disaster risk reduction, some of them in line with international frameworks like the Hyogo framework for action (2005–2015), or the Sendai framework (2015–2030). Given the great climatic changes challenging society, together with socio-political changes, disaster risk reduction seems an evident priority for governance, yet this seems to be a subject that is not often mentioned on governmental agendas. While the literature has tended to focus on the substance of disaster risk reduction, little research is available on learning about the design, application, and operationalization of disaster risk governance. Most of the case studies in the literature are in countries of the global north, where systems are well established, information is abundant, and communication networks are strong. Regions with dynamic environments, where socio-political and economic systems are constantly changing and information is not accessible, may require a new approach and specific cases to support changes, adjustments, and additions to existing concepts of disaster risk governance.

But how are existing concepts of disaster risk governance translated into potential and applied ways of dealing with dynamic environments in the context of disaster risk reduction? With the United Nations International Strategy for Disaster Reduction (UNISDR) and the Intergovernmental Panel on Climate Change (IPCC) definition of disaster risk and the International Risk Governance Council (IRGC) framework for risk governance, this study evaluates disaster risk governance with an interdisciplinary approach in a specific case. The core of the case study is Rio de Janeiro State, one of the most dynamic states in Brazil in terms of population and economic growth affected by floods, droughts, and landslides. Through 391 quantitative questionnaires, 26 semi-structured qualitative interviews, 11 focus groups and 3 workshops, plus secondary data and participant observation, it reveals the institutional arrangement of the state, the perception of the population living in the risk areas of Nova Friburgo – one of the most affected municipalities in 2011 – the participatory mechanisms implemented by institutions involved, and the relationship of communication and power between public power and civil society.

The main factors for disaster risk governance according to peer-reviewed literature are explored and prioritized through a quantitative literature review method. These factors added to secondary data and an integrated participatory methodology are the base for the field research in the state of Rio de Janeiro. Local population perceptions in the risk areas of Nova Friburgo municipality and their main influences are revealed using descriptive statistics, factor analysis, and regression on the survey results. Participation is determined in institutional processes through interviews and by applying Fung's triangle of participation. The solid outcomes of participatory mapping at different levels are measured and compared to explore applied and potential ways of dealing with disaster risk reduction. Governance, communication, and power connections are finally analyzed through three workshops and all the previously described processes.

In disaster risk governance, public power and civil society have different interests and a complete win-win situation is very unlikely. Decision-making in risk governance processes has to deal with trade-offs that need to be understood and considered by all stakeholders. Factors like lack of trust, miscommunication, and negative perception are especially difficult to address and may not be eliminated completely but can be considerably diminished. State institutions working for disaster risk in a mostly top-down, centralized system that does not enforce participation creates polarization, mistrust, and only few communication and meeting points between the civil society and public power. Abrupt changes to the top-down system do not affect the organized civil society at the same velocity. While consequences of changes are immediate in respect of public power (budget cuts, structural changes, and positions shifting), civil society will only shift in the long term at a slower pace. Even with future changes in the government strongly influencing these processes in other directions, networks should grow stronger and remain dynamic.

The feeling of neglect in these trade-offs in the population living in risk areas requires an understanding of the complexity and the actors involved in order that they feel acknowledged. Clear communication of how the decisions are made, added to an opportunity to take part in those decisions should be a key component and a starting point for better risk governance, followed by continuity of those processes to improve perception and trust. Enabling societies to benefit from constant change while avoiding the negative consequences of the associated risks, as the IGRC affirms, requires cohesion of the different stakeholders. Implementing examples, such as the one presented in the case study, on a bigger scale will require significant effort, time, and resource investment. This specific case can also be used to improve appraisal, communication, and management in surrounding areas and similar cases in peri-urban areas with rapid growth and high dynamism. With greater and stronger changes forecast, continuity (a key factor of all governance processes) is, and will remain, a real challenge in Brazil, requiring physical and temporary space on the agendas of all stakeholders.

Resumo

Entre 1980 e 2015, cerca de 1,6 bilhões de pessoas foram mortas em desastres meteorológicos, geofísicos, hidrológicos ou climatológicos. Estima-se que as perdas anuais futuras atinjam US$ 314 bilhões apenas no ambiente construído. O número de eventos de perdas naturais relevantes em todo o mundo mais do que dobrou nos últimos 30 anos, causando perda de vidas, danos à infraestrutura e um impacto negativo na economia. Instituições governamentais e não-governamentais começaram a investir na redução do risco de desastres, algumas delas em linha com quadros internacionais como o quadro de ação de Hyogo (2005-2015), ou o quadro de Sendai (2015-2030). Dadas as grandes mudanças climáticas que desafiam a sociedade, juntamente com as mudanças sociopolíticas, a redução do risco de desastres parece ser uma prioridade evidente para a governação, mas este parece ser um assunto que não é frequentemente mencionado nas agendas governamentais. Enquanto a literatura tem tendido a focar na substância da redução do risco de desastres, pouca pesquisa está disponível sobre a aprendizagem sobre o desenho, aplicação e operacionalização da governação do risco de desastres. A maioria dos estudos de caso na literatura estão em países do norte global, onde os sistemas estão bem estabelecidos, a informação é abundante, e as redes de comunicação são fortes. Regiões com ambientes dinâmicos, onde os sistemas sócio-políticos e econômicos estão em constante mudança e a informação não é acessível, podem exigir uma nova abordagem e casos específicos para apoiar mudanças, ajustes e acréscimos aos conceitos existentes de governança de risco de desastres.

Mas como é que os conceitos existentes de governação do risco de desastres são traduzidos em potencial e formas aplicadas de lidar com ambientes dinâmicos no contexto da redução do risco de desastres? Com a Estratégia Internacional das Nações Unidas para a Redução de Desastres (UNISDR) e a definição de risco de desastres do Painel Intergovernamental sobre Mudança Climática (IPCC) e o quadro do Conselho Internacional de Governação de Risco (IRGC) para a governação de risco, este documento avalia a governação de risco de desastres com uma abordagem interdisciplinar num caso específico. O núcleo do estudo de caso é o Estado do Rio de Janeiro, um dos estados mais dinâmicos do Brasil em termos de população e crescimento econômico afetados por inundações, secas e deslizamentos de terra. Por meio de 391 questionários quantitativos, 26 entrevistas qualitativas semiestruturadas, 11 grupos focais e 3 oficinas, além de dados secundários e observação participante, revela o arranjo institucional do Estado, a percepção da população residente nas áreas de risco de Nova Friburgo - um dos municípios mais afetados em 2011 -, os mecanismos participativos implementados pelas instituições envolvidas e a relação de comunicação e poder entre poder público e sociedade civil.

Os principais fatores para a governança do risco de desastres de acordo com a literatura revisada por pares são explorados e priorizados por meio de um método de revisão quantitativa da literatura. Esses fatores somados aos dados secundários e a uma metodologia participativa integrada são a base para a pesquisa de campo no estado do Rio de Janeiro. As percepções da população local nas áreas de risco do município de Nova Friburgo e suas principais influências são reveladas usando estatística descritiva, análise fatorial e regressão nos resultados da pesquisa. A participação é determinada nos processos institucionais por meio de entrevistas e pela aplicação do triângulo de participação de Fung. Os resultados sólidos do mapeamento participativo em diferentes níveis são medidos e comparados

para explorar formas aplicadas e potenciais de lidar com a redução do risco de desastres. A governação, a comunicação e as conexões de poder são finalmente analisadas através de três workshops e todos os processos descritos anteriormente.

Na governação do risco de desastres, o poder público e a sociedade civil têm interesses diferentes e é muito improvável que haja uma situação em que todos ganham. A tomada de decisões nos processos de governação de risco tem que lidar com trade-offs que precisam de ser compreendidos e considerados por todos os intervenientes. Fatores como falta de confiança, falta de comunicação e percepção negativa são especialmente difíceis de abordar e podem não ser eliminados completamente, mas podem ser consideravelmente reduzidos. As instituições estatais que trabalham em prol do risco de desastres num sistema centralizado de cima para baixo que não impõe a participação, criam polarização, desconfiança e apenas alguns pontos de comunicação e reunião entre a sociedade civil e o poder público. Mudanças abruptas no sistema de cima para baixo não afetam a sociedade civil organizada na mesma velocidade. Embora as consequências das mudanças sejam imediatas em relação ao poder público (cortes no orçamento, mudanças estruturais e mudança de posições), a sociedade civil só mudará no longo prazo a um ritmo mais lento. Mesmo com mudanças futuras no governo influenciando fortemente esses processos em outras direções, as redes devem se fortalecer e permanecer dinâmicas.

O sentimento de negligência nestes trade-offs na população que vive em áreas de risco requer uma compreensão da complexidade e dos actores envolvidos para que se sintam reconhecidos. A comunicação clara de como as decisões são tomadas, somada a uma oportunidade de participar dessas decisões, deve ser um componente chave e um ponto de partida para uma melhor governança dos riscos, seguida pela continuidade desses processos para melhorar a percepção e a confiança. Permitir que as sociedades beneficiem de mudanças constantes, evitando ao mesmo tempo as consequências negativas dos riscos associados, como afirma a IGRC, exige a coesão das diferentes partes interessadas. A implementação de exemplos, como o apresentado no estudo de caso, em maior escala exigirá esforços, tempo e investimento de recursos significativos. Este caso específico pode também ser utilizado para melhorar a avaliação, a comunicação e a gestão nas zonas circundantes e casos semelhantes em zonas periurbanas com rápido crescimento e elevado dinamismo. Com a previsão de mudanças maiores e mais fortes, a continuidade (um fator chave de todos os processos de governança) é, e continuará sendo, um verdadeiro desafio no Brasil, exigindo espaço físico e temporário nas agendas de todos os stakeholders.

Acknowledgements

The author would like to thank:

The Center for Natural Resources and Development (CNRD), with the support of the German Ministry for development cooperation (BMZ) and the German Academic Exchange Service (DAAD), for providing a complete 3 yearlong PhD scholarship to conduct this research. Logistical support, network and accommodation during the field researches were provided by the Integrated eco technologies and services for a sustainable Rural Rio de Janeiro project (INTECRAL), funded by the German Federal Ministry of Education and Research (BMBF) and supported by Rio Rural, a development program of the State Secretary for Agriculture and Livestock (SEAPEC) in Rio de Janeiro. Additional resources for one field research were given by Fiat Panis, Food and Agriculture Organization of the UN (FAO).

Prof. Dr. Mariele Evers for being the main supervisor of this study and the included publications during all these years, for her support from the beginning since the main concept, introducing the fascinating concept of risk governance to this work and for the collaboration with the analysis of the results and discussion. To Prof. Lars Ribbe for his support on the publication of the papers and guidance, specially at the beginning of this long journey. To Prof. Udo Nehren for his availability on such a short notice and his unconditional support during these years.

All interviewed and surveyed in the state of Rio de Janeiro that with their input and participation contributted with the narration and development of this work. To the INTECRAL team and the Rio Rural staff. A o pessoal de apoio em Brazil: muito obrigada por dar-me a oportunidade de conhecer a profundidade a realidade do estado do Rio de Janeiro e a maravilhosa regiao serrana. obrigada por guiar-me neste longo caminho da governanca, a qual, apenas comecei a caminhar. Um agradecimento especial a Conrado, Jackson, Fernando e Felipe por ajudar-me na fase do projeto em Brasil e a André, Marcelo e Jarvaz por todo o conhecimento compartilhado.

To those that colaborated at some phase of the development of this project: Toa for the neverending revisions, comments and excellent feedback, Min and Javier for the contribution on the first publication in the World Water Week, Guido for his selfless guidance in the statistics world, and also Ramses, Penedo Fabian, Marcos and Joscha for the contributions, ideas and technical advice.

To those that were always there creating a beauthiful universe far away from my dissertation: Maruja, Tere, Markich, Abdul, Chucho, Paulich, Lore, Adri, Marcolito, Jannis, Angela and the whole Kölle family. Thanks for the chaos and warmth in the middle of winter, the meals, parties, carnevals, films and all kind of meetings.

A mi familia y raíces Bolivianas, por estar siempre tan cerca y siempre presente, por darme la base para crecer. Muchísimas gracias a mi madre, mi padre, a mis hermanos nikilin y bubita, a mis cuñadas que se acoplaron a la familia y a los sobrinos que fueron apareciendo por el apoyo incondicional a larga y corta distancia en Bolivia, Brazil y Alemania y por siempre creer en mi. Dedicado al Chilichuño y al Tacu, que lograron hacer la presión y alivio que nadie más pudo para finalizar este proyecto 😊.

And finally, a la Pachamama, Wiracocha, Oxum, Ganesha, Jehova, Iemanjá, ao Santo Daime, Zeus, Shiva, Inti, Budda, Tláloc, Alá and Mother Nature in all the forms, flavors, colours and sounds manifested in this world in every bit of the day.

Content

List of figures

List of tables

List of abbreviations / acronyms

AGEVAP - Agência da Bacia do Rio Paraíba do Sul (Paraiba do Sul Water basin Agengcy)

ANA - Agência Nacional de Águas, Brazil (Water National Agency)

CD - Defensa Civil (Civil defence)

CEDEC RJ – Coordenadoria Estadual de Defesa Civil (Civil Defence state coordinator Rio de Janeiro)

CEMADEN - Centro de Monitoramento e Alerta de Desastres Naturais, Rio de Janeiro (Centre for Natural Disasters Monitoring and Alert)

CIEM - Centro de Informação e Emergências Ambientais (Center for Information and Environmental Emergencies)

COMDEC - Coordenadoria Municipal de Defesa Civil (Coordination Office of the Municipal Civil Defense)

CONDEC - Conselho Nacional de Defesa Civil (National Council on Civil Defence)

CONSEA - Conselho Nacional de Segurança Alimentar e Nutricional (National Council for Food Security and Nutrition)

CONSEG - Conselhos Comunitários de Segurança (Security Community Councils)

CPRM - Centro de Pesquisas para Recursos Minerais, Brazil (Mineral Resources Research Center)

DE – Dynamic Environments

DRG – Disaster Risk Governance

DRP – Disaster risk perception

DRR - Disaster Risk Reduction

DRM - Serviço Geológico do estado do Rio de Janeiro (Geologic Service of Rio de Janeiro)

EMOP – Empresa de obras públicas do estado do Rio de Janeiro (Rio de Janaeiro public works company)

ESDEC - Escola de Defensa Civil (School of Civil Defense)

FG - Focus groups

FIOCRUZ - Fundação Oswaldo Cruz (Oswaldo Cruz Foundation)

FRP – Flood risk perception

FUNCAP - Fundo Especial para Calamidades Públicas (Special Fund for Public Calamities)

GWP - Global Water Partnership

HIM – Hard intervention measures

HFA – Hyogo framework for action

IBASE - Instituto Brasileiro de Análises Sociais e Econômicas (Brasilian institute for social and economial análisis)

IBGE - Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics)

Incid – indicadores da cidadania (Ciitizen indicators)

INEA - Instituto Estadual do Meio Ambiente, Rio de Janeiro (State Secretary for Environment)

INMET – Instituto Nacional de Metereologia (Metereological institut)

IPCC – Intergovernmental Panel on Climate Change

IRGC – International Risk Governance Council

JICA - Japan International Cooperation Agency

NF – Nova Friburgo Municipality

SCD/SEDEC - Secretaria Nacional de Defesa Civil (National Secretariat of Civil Defence)

SIM – Soft intervention measures

PM - Participatory Mapping

RG – Risk Governance

Rio Rural - Programa de Desenvolvimento Rural Sustentável em Microbacias Hidrográficas, Rio de Janeiro (Sustainable Rural Development Programme in small watersheds)

RJ – Rio de Janeiro State

SEDEC - Secretaria de Defensa Civil Rio de Janeiro (Secretary of Civil Defense)

SEOBRAS - Secretaria estadual de Obras, Rio de Janeiro (Secretary of infrastructure)

UNISDR - United Nations International Strategy for Disaster Reduction

INTRODUCTION CHAPTER

1 How to estimate and operationalize disaster risk governance?

Research question and case study area.

1.1 Introduction

1.1.1 Disaster risk reduction and risk governance

The number of relevant natural loss events worldwide, including meteorological, geophysical, hydrological, and climatological disasters has more than doubled in the last 30 years. Hydrological events occupy the largest proportion of the four mentioned categories accounting with 41.5% of relevant events and 35.3% of catastrophic events (Munich Re, 2018). As natural disaster risk increases, disaster risk reduction and governance are very important unyielding matters to minimize negative impacts (Ceddia et al., 2017; OECD, 2014, 2017). After an estimated loss of 1.6 billion people killed in disasters between 1980 and 2015, confidence is high to support the fact that disaster risk is not only growing in frequency as natural hazards increase, but also the number of affected people is growing as vulnerability increases (Pachauri and Mayer, 2015). The global assessment report on disaster risk reduction of the United Nations confirms the increasing trend of mortality and economic losses associated with recurrent disaster risks. It estimates future annual losses of US$314 billion in the built environment alone, an amount that will be five times higher for low-income countries in comparison to high-income countries (UNISDR, 2015a).

The study here presented uses the official risk definition of the United Nations International Strategy for Disaster Reduction (UNISDR) and the Intergovernmental Panel on Climate Change (IPCC) where disaster risk is a result of the complex interactions of hazard, exposure, and vulnerability. According to the IPCC, the severity of the impacts of extreme and non-extreme weather and climate events strongly depends on the level of vulnerability and exposure to these events (Cardona et al., 2012). Vulnerability plays a larger part in the risk equation in the case of extensive risk layers, meaning high frequency but low severity losses like flash floods, landslides, and storms (UNISDR, 2015a). The document “Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation” reports that vulnerability and exposure are dynamic, change across time and space, and there is high confidence that they are aggravated because of skewed economic, social, geographic, demographic, cultural, institutional, governance, and environmental development processes (environmental mismanagement, wealth, education, demographic changes, health status, unplanned urbanization, failed governance, and the scarcity of livelihood options for the poor) (Cardona et al., 2012). These relatively new definitions place governance at a high level of importance.

Vulnerability is complex and its definition requires the consideration of environmental and social conditions that limit coping capacities, and even though it includes exposure in its definition, not all those exposed are necessarily vulnerable (Birkmann, 2013). The value of risk governance is becoming evident. The quality of risk governance is one of the two most correlated factors to disaster mortality risk, and weak governance is one of the factors increasing extensive disaster risk (UNISDR, 2015a). Since most of the dynamic processes defining risk reduction, especially vulnerability, are structured by risk governance, it seems necessary to go deeper into the definition of risk governance and analyze the specific relation of risk governance to risk reduction in the field. In 2003, the International Risk Governance Council (IRGC), an independent non-profit foundation emerged, aiming to help the understanding and management of risks. Contributing to the concept of risk governance and opening a discussion on specific issues, the IRGC has some examples of the application of the concept of natural risks, but few of them are in developing countries.

Defined as the institutional structure and policy process for risk reduction taken by a society or a collective (Klinke and Renn, 2012), the overall definition of risk governance (RG) evolved from a risk assessment – management – communication concept. In Renn's definition of RG, three main components are described: communication, assessment, and management (Renn et al., 1992). Being a simplified causal sequence, the need for looping in this linear process is evident. The IRGC presented a framework (IRGCF) in 2005 that improved the classical definition of risk analysis, added characterization and monitoring to it, and divided the process into appraisal and management. The IRGCF is one of the most accepted definitions and embraces all kinds of risks, has multiple applicability, and a broad perspective. The IRGCF was a progression and extension of both the US National Research Council (NRC) 1996 and the Royal Commission for Environmental Pollution (RCEP) 1998 models (Renn and Walker, 2008a). The first model suggested by the IRGC presents six major governance phases: pre-assessment, risk appraisal, tolerability and acceptability judgment, categorization of knowledge and evaluation processes, risk management, and communication as a central aspect (IRGC, 2005). The processes were categorized in a sphere of decision and understanding. Combined with the UNISDR definition, where disaster risk governance refers to the specific arrangements that governments, the private sector, and all individuals in general put in place to manage their disaster risk, this study uses the IRGCF for the definition of disaster risk governance (DRG).

The IRGC framework was partially applied by the European Food Safety Authority and the Health Council of the Netherlands. It was used to create some reports by the German Occupational Safety Committee, the International Occupational Safety Association, the UK treasury, and the US Environmental Protection Agency (US-EPA). The main limitation of this framework, for this work, is that the IRGCF is principally used for technological risks (e.g., biochemical agents in a factory or cyber security) rather than natural risks. The proposed risk taxonomy divides the framework into six agents, forces, and hazards, from which only "natural forces" focuses on natural hazards. "Social-communicative hazards" including mass hysteria and "complex hazards" including critical infrastructure may be partially connected to natural hazards. Under the main process of the modified framework (Klinke and Renn, 2012) there are three elements: "human resources social capital", "financial and technical resources", and "institutional means" in this socio-institutional and economic foundation, a drawback in the physical environment that must be recognized (Figure 1.1).

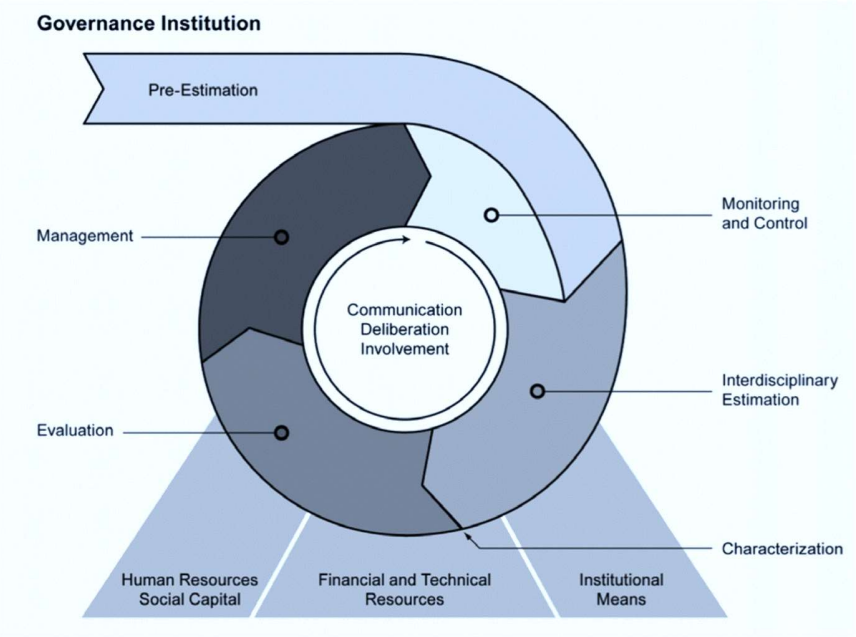


Figure 1.1 Adaptive and integrative risk governance model (Klinke and Renn, 2012)

In the book *Global Risk Governance*, Eugene Rosa criticizes the IRGCF in the definition of risk as a mental construct or as a real phenomenon that marks the struggle of the social realm (constructivism) and states it is contradictory to the natural science realm (realism) (Renn and Walker, 2008a). The distinction between appraisal and management is marked, converting it into a polarized process. However, the IRGCF not only includes those risk processes, but also considers contextual factors such as institutional arrangements and political culture.

During the last few years, the IRGC updated publications about risk governance that contain much more discussion about political systems and stakeholder involvement (see table 1.2) than previous years, making them a key instrument for risk governance. As a main tool and mechanism to deal with risk, the IRGC framework together with all improvements, criticisms, and other publications are considered in the analysis of a case study. Even though there are slightly different definitions in the documents presented, the main factors of risk governance for the IRGC and other frameworks are research and knowledge, stakeholder involvement, and communication (chapter 6). **Being conceptual documents, a question remains open about the estimation, application, and operationalization of these concepts in real cases and the considerations needed according to geographical and social differences.** Recorded examples of applications of these concepts in natural hazard cases in an interdisciplinary form are especially limited. To better understand the limitations, this study defines and analyzes the main factors in risk governance linking them with a case study of a dynamic environment.

1.1.2 Dynamic environments

With no official definition of dynamic environments (DE) in the socio-environmental realm, the definition used for this study integrates different schools of thought and finds common aspects and interactions at a multidisciplinary level. In 1979, the DE definition emerged in the economy and marketing school, as the representation of the perceived frequency of change and turnover of the

external/task environment (de Ven, Andrew H. Van and Aldrich, 1979). This construct has been referred to as environmental variability or volatility by Child in 1972, changes in consumer preferences by Miller in 1988, and as a dimension of environmental uncertainty by Scott in 1992. The agreement between these definitions affirms that DE are unpredictable, and devoid of patterns and regularities (Dess and Beard, 1984). Ravipreet Sohi (Sohi, 1996) included changes in technology, customer preferences, and competitive action; Wijbenga and van Witteloostuijn defined it as a wide set of indicators to predict behavior with an interaction-effect model (Wijbenga and van Witteloostuijn, 2007).

In social sciences, Cohen introduced the term "social change" through four criteria related to alterations in principles by which people are recruited and controlled, distribution of authority, and labor division (horizontal arrangements) (Cohen, 1983). Turchin simplified it with models, using factors such as urban and political development, demographic, socio-structural, and technological changes (Turchin et al., 2006). Barkan (Barkan, 2012) and Wright (Wright, 2015) added a qualitative approach, with factors such as the transformation of culture (meaning rites, tools, languages, hierarchies), rules, norms and values, behavior, social institutions, forms, and structure over time.

In the natural realm, Gibson proposed the term DE in the environmental sciences to define a rapid rate of change in time (Gibson et al., 2000a). Ostrom, as a political economist, identified the most valid theories and defined a framework for "environmental change" considering socio-ecological systems and including governance (Ostrom, 2008). For Ostrom, the integration of social and ecological systems seems evident for disaster risk governance, but the quantity of constantly changing variables and factors defining DRG, makes it more complex. In the Millennium Ecosystem Assessment (MA) of the United Nations, the unit taken for environmental changes is the ecosystem processes and the ecosystems. The MA demonstrated that changes in these ecosystems increased in the second half of the 20th century more than at any time in recorded history (Reid, 2005). Man-made causes (habitat change, anthropogenic pressure, land-use change, and physical modification of rivers or water withdrawal from rivers) are major forces changing and shaping ecosystem dynamics, creating overexploitation, invasive alien species, pollution, and climate change among others. The IPCC reported that apart from increases in frequency and severity of events, "the spatially diverse and temporally dynamic patterns of exposure and vulnerability" also affect disaster risk (IPCC, 2012), creating a dynamic risk that increases uncertainty (IRGC, 2013; Lawrence et al., 2013) and has a negative effect on human well-being and poverty alleviation.

Nowadays, negative influences of humans on the earth's systems are happening on an unprecedented scale in complex, interactive, and accelerating ways (Reid, 2005; Steffen and Eliott, 2004; Rice and Henderson, 2012; Burch et al., 2019). Socio-ecological systems are composed of many parts that interact with and adapt to each other (OECD, 2009). For instance, rapid population expansion and urbanization or peri-urbanization increase dynamism and may not be addressed by regulation measures fast enough, provoking over- or under-regulation (Webster, 2002). In an actual real-life context, the dynamic characteristics mentioned are stronger in developing countries where urbanization is rapid, and especially in peri-urban areas, where urbanization processes and changes are mostly happening (Moreira et al., 2016) and industrialization is taking place (Tian et al., 2016). The study area in this document is a perfect example of dynamic environments, connecting major sources of social and environmental change including population growth, expansion and composition, urbanization, globalization, culture, new communication media, technology, social innovation, and

social conflict, and illustrating the necessity of an interdisciplinary perspective to address it. With all such processes increasing, considering, and prioritizing the dynamicity of an environment for disaster risk governance seems evident. **Nevertheless, concrete ways to estimate and improve governance or examples of how to apply and operationalize recommendations about disaster risk governance are missing.** The greatest challenges arising from these kinds of human-environment interactions start with the difficulty of predicting such changes and go beyond communication and action, involving these intricate system responses to multiple, complex, and interacting stresses (Steffen and Eliott, 2004).

1.2 Case study area - Rio de Janeiro

Founded in 1565 as the capital of the Portuguese colony, the area of Rio de Janeiro became active as an important commercial center and one of the main connections to the rest of Brazil. After 1763, Brazil became independent and Rio de Janeiro remained as one of the economic and cultural centers of the country. The latter is reflected in the constantly growing population, from 1 million in the city in 1920 to 16.64 million in the state in 2016, according to the Brazilian Institute of Geography and Statistics (IBGE). This population and economic growth demanded more and more production in the surrounding area, where the Mata Atlântica (Atlantic Forest) was abundant. The population living in the rural areas started clearing the forest for coffee production and later they switched to cattle production. The unsustainable and inappropriate land use has caused degradation of pasture and severe land problems that are pushing the rural population to urban areas and, at the same time, increasing the urban and peri-urban limits.

Being the third smallest state in Brazil, the area of the state of Rio de Janeiro is comparable to the area of Switzerland (43,780 km^2). Located in the biome of the Mata Atlântica, one of the 36 global biodiversity hotspots (CEPF; www.cepf.net), the state is very rich in natural resources. The tropical location, the steep ranges, and the coastal mountains reaching 2700 m.a.s.l. create various landscapes, climates, and ecosystems that increase biodiversity. Although this mountainous topography hindered intensive exploitation of the land, and in some cases made it impossible, the Atlantic forest biome has reduced by approximately 93% from its original size since the arrival of the Europeans (Strassburg et al., 2016). Most of the forest that is left equates to the mountainous area (*Figure 1.1*2).

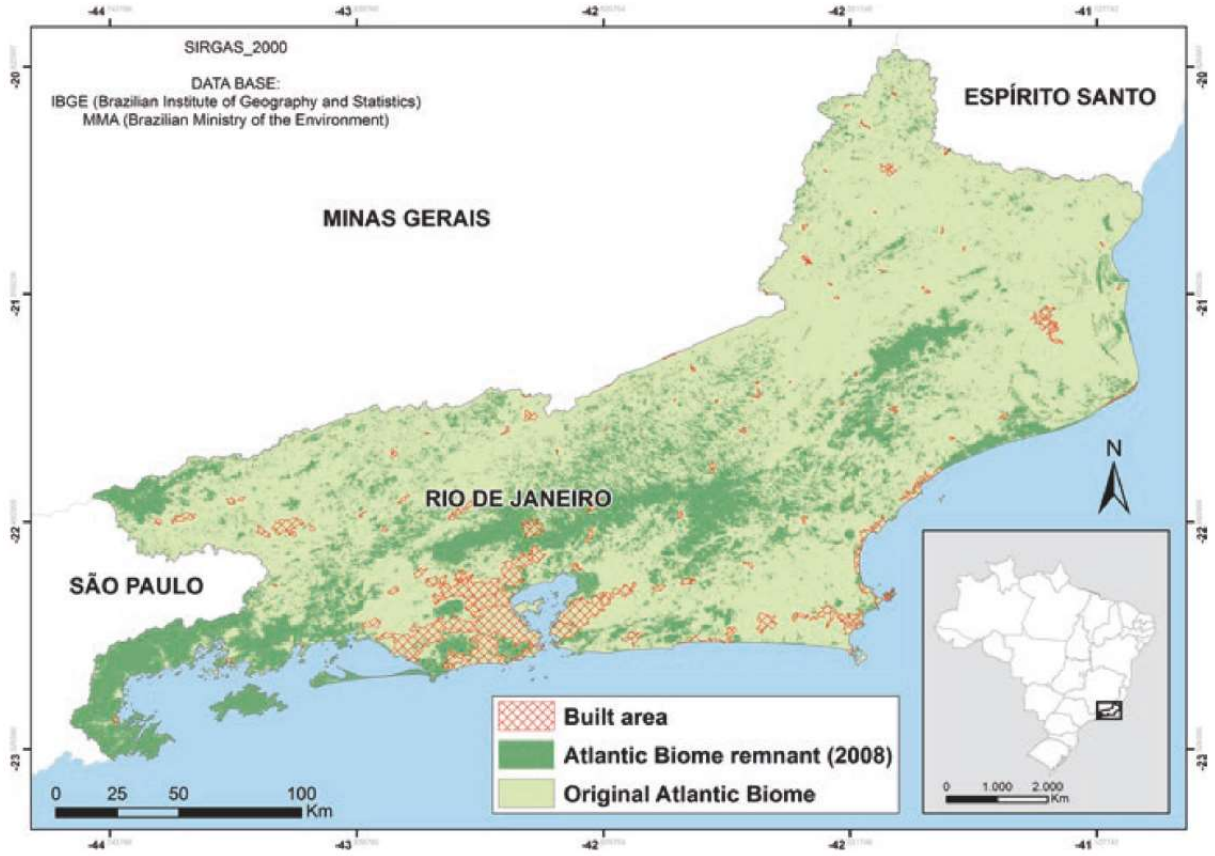


Figure 1.2 Atlantic forest remnant in the mountainous areas, Rio de Janeiro state (IBGE, 2008)

Before the arrival of Europeans in 1500, the area was occupied by the Tupi-Guaraní population who practiced rotational agriculture in the forested areas. With the arrival of the Europeans, these practices were also adopted and adapted, and slash and burn practices were widely used in the area. Despite discussions, these practices ensured nutrient cycling and ecological sustainability (Adams et al., 2016). It was later, with the extraction and export of trees for energy and wood, that the deforestation started to become noticeable. Five hundred years of sugar cane production together with charcoal, and later coffee, greatly modified the soil and the forest. After the abolition of slavery in 1888 the lands were transformed to grazing, which required less workforce. The state now represents mostly an anthropogenic landscape, despite the little forest growth in many areas (Nehren et al., 2019).

With the increase of the population in the urban centers, the intensive production was further pushed north to the state of Minas Gerais and other states. Cattle production and small-scale agriculture remains in the state and is rapidly being replaced by the urban and peri-urban borderlines. Nowadays, the population and industries are concentrated in the metropolitan region, in the southern center of the state, in an area including 30 of 92 municipalities in the state. With an area of 6745 km^2 and 12.3 million habitants (IBGE, 2017), the metropolitan region of Rio de Janeiro is among the three most populated and economically active regions in Brazil. North of this region, just beyond the mountainous chain, is the “Centro Fluminense” or “Serrana” region. With 16 municipalities, of which Nova Friburgo is among the most active economically, it has a population of only 0.47 million habitants (IBGE, 2017).

Rio de Janeiro is the first industrial state in the country, demonstrating considerable economic growth after the economic recovery of the last 20 years. This growth significantly changed migration patterns in the whole state. Producing more than 82% of the national oil production, and with a GDP per capita of 26,250 R$ (+/-8,402 US$) (IBGE, 2017), there was an evident increase in the dynamism of the social, economic, and environmental spheres. Consequently, the urban expansion and informal settlements have also increased during recent years, ahead of any municipality plan.

The study covers many governance aspects of the state of Rio de Janeiro and uses several cases and studies from Nova Friburgo municipality as a great example of rapid growth and dynamicity. Nova Friburgo municipality has a population density of approx. 200 hab./km^2 (IBGE, 2010) and is the fourth most populated municipality in the state. It was first populated by Purí Indigenous peole, and in 1818 a Swiss colony was established in the mountainous area, located 150 km away from Rio de Janeiro city. Swiss, German, Portuguese, and Italian communities started settling down around this same area. In 1910, pioneering industries arrived in the area, increasing the demand for labor and resources. Up to the present day, the expansion of Nova Friburgo municipality is one of the fastest in the country, being in the 150th position from 5570 municipalities (IBGE, 2010). With houses expanding to even steeper slopes and infrastructure canalizing the rivers, water has begun to distribute to other areas and landslides have ocurred both on and under the houses.

1.2.1 Disaster risk

The story of Brazil and disaster risk reduction efforts starts in 1824 when article 179 of the national Constitution guaranteed public aid, to 1960 when the country shifted from war-oriented protectionism, understanding risk as war-like attacks, to natural disaster effects' compensation (Universidade Federal de Santa Catarina, 2012). From 2005, the Hyogo Framework for Action of the United Nations was implemented in Brazil together with 167 other countries, aiming to increase resilience and implement disaster risk reduction (DRR) measures until 2015. The implementation level was different along country, but with a great advantage for the largest states in terms of investment, organization, and implementation processes. Even so, Rio de Janeiro had a long way to go and many challenges to cope before implementing the Sendai framework (Bustillos Ardaya et al., 2015). Many disasters had affected the most populated areas of Brazil during the period of this action. Santa Catarina, Alagoas, and Pernambuco suffered severe damage in 2010 and 2008 due to floods and landslides.

Flash floods, floods, and landslides have long affected the state of Rio de Janeiro, especially on the west to east mountain chain that reaches more than 2000 m.a.s.l. The orographic barrier blocks the oceanic currents coming from the south provoking heavy rainfall on the mountainous area and increasing the level of rivers in the north and south direction. During years 1988, 1996, 2005, 2007, and 2010 severe rains caused several floods with severe consequences (Ferreira, 2016). The increase in the frequency and magnitude of these phenomena are both due to the climatic, geomorphologic, and geologic characteristics of the area (e.g. tropical climate, weathered soils, and extensive mountainous areas) and to the presence of areas characterized by high population density and unplanned and spontaneous land occupation that has caused deforestation and a high impact on the soil (Coelho-Netto et al., 2007). Even though well-preserved forest can better mitigate landslides and erosion (Netto et al., 2013), it cannot completely eliminate them (Nehren et al., 2019). Several landslides also ocurred in dense forested areas after these events. In addition to land use change, the

rectification and channelization of rivers increases the water flow speed aggravating flood events, creating higher and more frequent peaks (dos R. Pereira et al., 2016).

In contrast to the floods, from 2014 to 2017 the states of Rio de Janeiro, São Paulo, and Belo Horizonte have suffered severe water scarcity. The causes are still being discussed, but climate factors caused by deforestation, urban heat island effects, and heatwaves combined with mismanagement of the water allocation (e.g. loss of water because of old infrastructure) are among the main causes (Nehren et al., 2019). All of these events are expected to increase in frequency and intensity in the future (Marengo, 2014). Projected climate change that will exacerbate water scarcity because of projected changes in precipitation patterns, extreme temperatures, and other climate variables, added to the water demand of growing populations, are creating several socio-environmental conflicts regarding water allocation through a severe (>20%) decrease in water resources (Schewe et al.,2013; IPCC; 2012).

1.2.2 Floods and landslides in 2011

Figure 1.3 Satellite pictures before and after the event, patches of the landslides to be seen (Google Earth, 2015)

The flash floods and landslides of 2011 were the worst weather-related disaster in the history of Brazil in terms of human, property, and livelihood losses. Seven cities in the mountainous region reported more than 1,000 deaths, over 100,000 people were left homeless, 300,000 were affected, and key infrastructure was destroyed, as confirmed by official data of the world bank and newspaper reports (World Bank, 2012). However, following calculations suggested that the actual losses were eight to ten times greater based on around 8,844 electricity meters lost (887 in Nova Friburgo) and registrations with the electric power company (Energisa) that were never rehired (Canejo, 2015; Custódio and Corrêa, 2012).

During the night of 10 January 2011, the national meteorology institute INMET registered 166 mm of accumulated precipitation for Nova Friburgo city, which exceeded 70% of January monthly average in only one night. The soil was saturated because of a rainy month, so the water level rose in a couple of hours. A representative of the geological survey service (DRM) confirmed that the strong thunderstorms during the rain triggered the landslides and the thin soil layer above the rock, characteristic of the mountainous areas, contributed to the hundreds of landslides (Figure 1.3). Roads, communications, energy, water, and sanitation facilities were destroyed leaving some regions isolated, as one dweller in Nova Friburgo confirmed: “on the third day after the tragedy I still didn’t

know if my family on the other side of the city was alive". Public infrastructure was lost, and productive sectors were also affected. The World Bank estimated a total of 2.2 billion R$ (1.3 billion US$) costs in direct damage. In Nova Friburgo city alone, houses and buildings located in or close to steep hills and close to the rivers were destroyed leaving around 39,000 people homeless or displaced. Most of these were informal housing (favelas). As one of the dwellers described of the São José neighborhood: "the entire neighborhood was under debris, unrecognizable". Increases in the frequency and severity of flood and landslide events together with the increment of affected people, make risk prevention a top priority in Rio de Janeiro, rising the investment in risk governance issues.

1.2.3 Institutional arrangement risk governance management

National institutions like the National Institute for Space Research (CPTEC/INPE), the Brazilian Ministry of Environment (MMA), and the National Water Agency (ANA) have detailed climate, environment, and water bodies' information at national level. This information, and in some cases projections, support state and municipal organizations in cases of disaster (Figure 1.4).

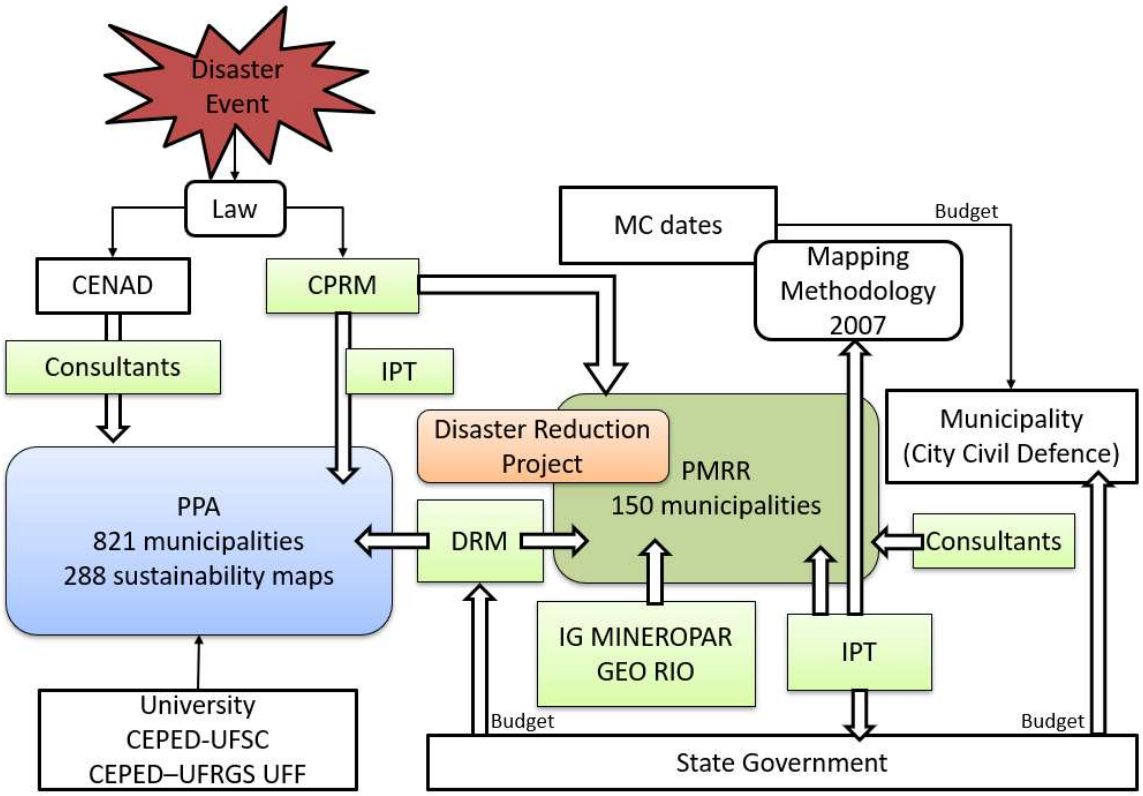


Figure 1.4. Map of processes after a disaster event (CPRM, 2013)

The National Center for Natural Disaster Monitoring and Alert (CEMADEN) at national level and the Secretariat of Civil Defense (SEDEC) in Rio de Janeiro State are responsible for articulating technical information received by the federal and local governments related to possible climatic events. This information is mostly provided by the State Institute for the Environment (INEA) and the Geological Survey Service of the State (DRM), according to the new institutional rearrangement (GITEC / IP/ CODEX REMOTE, 2013), created after the 2011 incident to define specific processes and products of

the institutions working on disaster risk reduction in the state (Reed et al., 2009). After the 2011 floods and landslides, local and international institutions focused on infrastructural and non-infrastructural projects in the most affected areas. After the reconstruction projects, led mostly by the state or municipal government with federal resources, institutions related to risk management, environment, and land use had to increase research and improve their work with the local population. Federal funds were released to increase the response and preparedness through awareness and training programs.

The INEA created the Center for Information and Environmental Emergencies (CIEM). This monitoring and warning system is a simple model. Water level information from telemetric monitoring stations is sent in real-time to INEA webpages, and a warning level (red, yellow, or green) is displayed according to stream overflow level calculations previously made for every station. This information is also sent by SMS to the registered population when thresholds are surpassed. The DRM risk maps are based on digital elevation model maps and historical information about previous landslides and developed in GIS by local technicians. Civil Defense (CD) and the municipal prefecture work directly with people who may be affected. They offer preparedness courses free of charge, survival kits, evacuation simulations with the sirens installed, information, and have developed a SMS alert system together with INEA (*Figure 1.5*). International organizations like Care International and the Red Cross, national institutions like INCID, IBASE and organized neighborhood associations and active citizens' groups also undertake different activities with the population living in risk areas in order to improve their knowledge and protection, as well as preparedness.

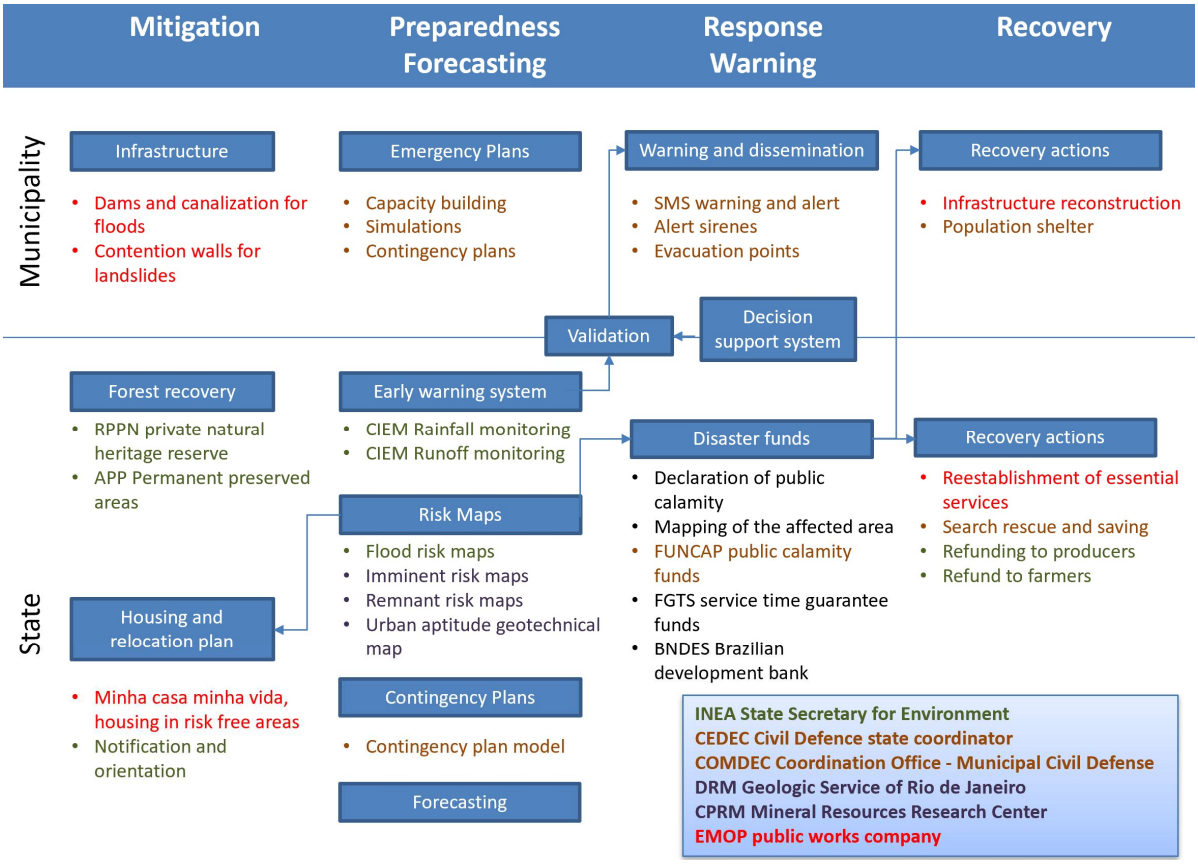


Figure 1.5 Main DRR processes of Rio de Janeiro institutions (based on GITEC / IP/ CODEX REMOTE, 2013)

1.2.4 Research, monitoring and Modelling

Research, as the OECD and the UNESCO defines it, is "any creative systematic activity undertaken in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this knowledge to devise new applications" (UNESCO, 2001). After the events of 2011, universities, governmental institutions and NGOs, had a stronger focus on the research of the affected areas, the affected population living in these areas, and the systematization of information concerning these areas. The number of master and PhD thesis about disaster risks in the mountainous regions in the field of exact sciences or social sciences increased (Ministério da Educação, 2018), together with the NGOs present in those areas with educational or assistance programs (e.g. CARITAS, UNICEF). The national plan for risk prevention allocated 18.8 billion R$ for response, prevention, monitoring and alert, and mapping. From the total budget, only 0.86% was invested to mapping and 1,93% to monitoring and alert (Federal government of Brazil, 2012), the rest was mostly invested in infrastructure for prevention and response. Governmental institutions with the mandate to implement a long-term approach, reorganized the institutions working on disaster risk management and created additional areas or institutions for risk reduction and response like the state center for civil defense (GITEC / IP/ CODEX REMOTE, 2013).

According to the Brazilian legislation, data created by public institutions must be available for the population to use. Most of the information that the municipality and Civil Defense (CD) use for management, comes from INEA. INEA offers open information about river basins (water level and quality), land areas (forests, protected areas, concessions, conservation areas and private properties), and biodiversity al the state level (variety and quantity of species). The Center for Information and Environmental Emergencies (CIEM), a new department of INEA is exploring the development of flood forecasting models with the information they manage. However, they have encountered several problems as one interviewed INEA expert pointed in 2015 when referring to the data processing: "several devices are from different projects, so it is very difficult to centralize data coming from a Sweden monitoring system and another German device". The basic flood risk model was released by INEA in 2012 and the imminent landslide risk maps were released by DRM starting on 2011.

Universities and other institutions involved with research have several studies on the region supporting research development and are trying to increase their network. NGOs are also considered as an influence on management and locals are invited to participate in the process for data collection in social studies. In the case of universities and research entities, public institutions are considered as one of the first references for primary information in environmental sciences. Public institutions are also the main source of information for decision making. Municipal governments for example, rely on state data and processes for urban planning and infrastructure investment. Like in many other Latin American countries, in Brazil the changes in public institutions are strongly linked to the current government policies. Strong fluctuations in politics like the impeachment of Dilma Rouseff in August 2016 lead to great changes on the administration of all public institutions. Strong budget cuts first declared on Bolsonaro personal twitter account, lead to releases in the personnel working in environmental and research institutions, specially the technical staff and experts, leaving mostly administrative staff and uncertainty among the remaining employees. The elected government of Jair Bolsonaro in 2018, has declared stronger cut on research and a merging of the environment and agriculture ministry. Both actions are taken as threatening, because of the dimension of the changes and the implications environment, research and other areas (Pereira et al., 2019; Pereira et al., 2020).

To operationalize the concepts of disaster risk governance in the case of Rio de Janeiro, a complete estimation of the state and direction of the actions are to be conducted. A series of methods need to be applied on the field to get a better picture of the appraisal, management, communication and participation mechanisms that the State has.

1.3 Research question and methodology

As many countries continue to face great losses because of disasters, a framework for disaster risk reduction and governance that is inclusive and clear to apply is crucial to building a better environment. The objective of this study is to analyze some of the implementation challenges and realistic tasks of international frameworks and manuals targeting disaster risk governance. By answering the research question:

"How are existing concepts about disaster risk governance (DRG) translated into potential and applied tools of dealing with dynamic environments in the context of disaster risk reduction?"

This study aims to study and compare the components of disaster risk governance from a top-down and bottom-up perspective with interdisciplinary approaches from the social and natural spheres. Three sub-questions support the main research question. The first refers to the existing concepts of risk governance. These are international, national, and local concepts dealing with disaster risk reduction, frameworks, and the existence or absence of a concept of dynamic environments or similar definitions. Exploring applied tools of dealing with dynamic environments, the second sub-question, required work in the field, to explore the implementation of disaster risk reduction programs and the results in the potential risk areas and the population living there. The third sub-question, "To explore the potential ways of dealing with dynamic environments in the context of disaster risk governance in a realistic realm" requires the expertise of the local stakeholders. The second and third sub-questions can best be answered by the perceptions of the experts, people involved in institutional programs working for disaster risk reduction and the population living in risk areas, in the field (*Figure 1.6*). The main research question analyzes the connections between the three sub-questions.

1) What are the **DRG definitions** and main factors presented in existing international concepts?
2) How are the existing DRG concepts **perceived and applied** by stakeholders on the field in the defined study area?
3) What other **potential concepts and tools** could improve DRG according to stakeholders in the defined study area?

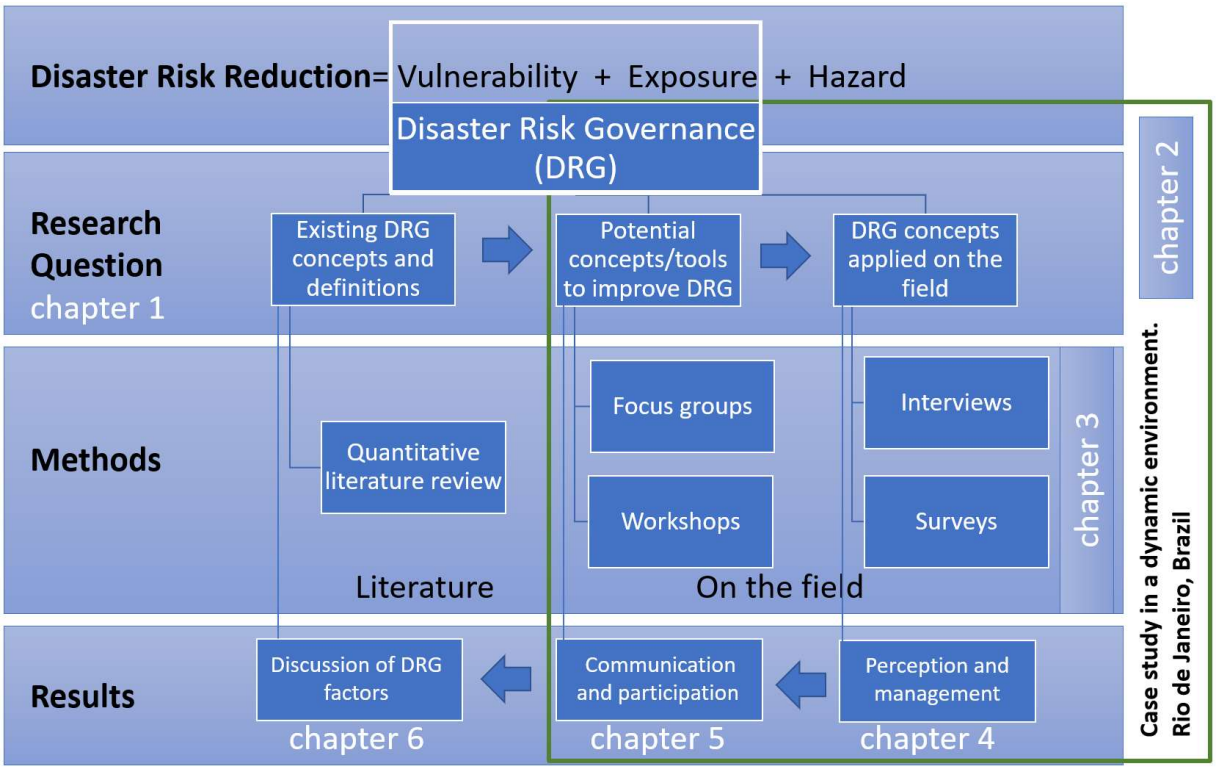


Figure 1.6 Relation of the research questions, the methods and the chapters of the dissertation

The results of each research sub-question are presented in chapter 4, 5 and 6. Chapters 2, 3, 4, and 5 are presented in this study exactly as they were published. To first analyze existing concepts of risk governance, frameworks and international scientific research papers were selected. In relation to international frameworks, the study focuses on the Hyogo Framework for Action 2005-2015 (the framework before the Sendai) and the IRGC (International Risk Governance Council) framework for risk governance. Since the Hyogo Framework for Action contains concrete accomplishment points that should be achieved by 2015 and an official report about the actions accomplished up to 2015 that has already been published, this study presents a point-by-point analysis of the actions accomplished by the State of Rio de Janeiro in chapter 2. Additionally, the second chapter introduces Rio de Janeiro and their ongoing work in disaster risk reduction.

The papers considered for this analysis were published in peer-reviewed English-language sources such as Google Scholar, Science Direct, and Springer that assess “risk governance” and were released between 2005 and 2018 (section 1.4). From more than 300 peer-reviewed papers found on the already mentioned search engines, 67 were related to environmental and social environments. The selected documents were processed with a quantitative literature review methodology (Pickering et al., 2015). To reflect the dynamicity of a context, references from 2005 to 2015 (prior to the Sendai framework) were compared with references from 2016, 2017, and 2018. The quantitative literature review of the frameworks and publications, described in the next sub-chapter, reveals the most important concepts in publications and frameworks about DRG, answering the first sub-question.

The main concepts related to risk governance set a base for the development of the methodologies on the field needed to answer the second and third sub-questions: applied and potential ways to deal

with dynamic environments in the context of risk governance. The exploration in the field was undertaken by participatory observation, interviews, surveys, focus groups, and workshops. The third chapter of this study describes in detail the joint methodologies used in this study. Table 3.1 in the third chapter summarizes the methodologies with references.

Participatory observation is used for all events, interactions and situations related to risk. The first interviews were targeted to experts working in state, municipal, and non-governmental institutions dealing with disaster risk reduction. The interviews clarify on appraisal, strategies, and measures taken and build a base for the survey structure. The surveys and following interviews are focused on the population living in flood risk areas and quantify their appraisal, strategies, and management. The resulting survey on the appraisal of the population living in risk areas (applied DRG) answers the second sub-question and is explained in chapter four, a publication in the International Journal for Disaster Risk Reduction (IJDRR), "What influences disaster risk perception?" (2017). Chapter four presents the results of the questionnaires made to the population living in flood risk areas and their perception of risk, measures, and the influences they have from institutions, organizations, and the local population. The surveys together with the interviews contribute to the selection of the population and specific subjects for the focus groups.

During the focus groups, three hours sessions organized for the population living in each of the considered risk areas, three main activities were taking place:

a. Timelines: to register past events, important dates in the location, and introduce participants.
b. Participatory mapping: to geo-reference the location of important infrastructure, flood and landslide prone areas, important locations for dialogue, and actions (e.g. evacuation routes).
c. Mind maps: to find better solutions to reduce disaster risk, and implementation strategies.

The results of the focus groups are presented in chapter five, a publication in the Land Use Policy Journal (2019). The chapter evaluates the participatory processes/schemes applied by institutions and focuses on the creation and use of risk maps. The participatory mapping, a tool used during the focus groups based on Ares and Risler (2013) methodology, gathers collective geographical information around risk areas. The outcomes and processes of the participatory mapping are compared to state and municipal risk mapping. The general outcome of the focus groups and the following analysis answers the third sub-question.

All previous methods contributed to building the workshops (participants, subjects, structure, and spaces for discussions needed). The workshops joined the population living in risk areas with institutions working in disaster risk reduction to discuss perception, participation, adaptation, and decision making in the field of risk governance through cognitive participatory mapping and policy exercises. The outcomes of the field research are linked back to the concepts related to risk governance and analyzed in chapter six to answer the main research question. Chapter six describes, links, and discusses the quantitative literature review with the case study. The significance of all previously described results and their relation to risk governance are analyzed in this chapter, applied DRG, potential DRG, and the reflection on the existing concepts. Chapter seven draws together the main conclusions from public power and civil society in risk governance. Building on a real case study, this study explains the challenges and concerns that must be considered in dynamic environments like Rio de Janeiro State, and elucidates how it can be applied to the entire region and other similar cases.

1.4 Quantitative literature review

For the literature review and to answer the first sub-question, original scientific research papers published in peer-reviewed English-language sources such as Google Scholar, Science Direct, and Springer that assess "risk governance" released between 2005 and 2015 were first selected. A simple search showed between 403 and 343 peer-reviewed results on official search engines. Most of the papers were not addressing risks of natural hazards, so those related only to "finance", "economics", "industry", "toxicology", "epidemiology", "medicine", "industrial production", "energy", "materials", "nanotechnology", "computer sciences", "food control" or "chemicals" were filtered and excluded from the selection. Excluding those papers, the results dropped to 56 (Science Direct) and 67 (Springer), of which only a few of the results were directly related to natural and social environments. A total of 35 publications for risk governance were selected and processed using the Pickering methodology for quantitative literature review (Pickering et al., 2015). This methodology was chosen because allows interdisciplinary research through the better inclusion of different methods and analysis. The discussion and connections between environmental, social, and political aspects required an interdisciplinary approach. All important factors contributing to risk governance, mentioned or analyzed in the documents, were extracted and quantified. The eleven most mentioned factors collected from these 35 publications outlined the main characteristics in risk governance that are crucial for assessing disaster risk reduction. To reflect the dynamicity of the definitions an frameworks, 30 more references from 2016, 2017, and 2018 (after the release of the Sendai framework) were added to these factors and to the further discussion.

All distinctions of the existing frameworks for risk governance were analyzed. The assessment comprised 12 documents from the International Risk Governance Council (IRGC), including the official IRGC framework report plus further corrections and improvements presented as core concepts of risk governance, before and after 2015 (IRGC, 2018). A total of 15 IRGC documents, 2 UN documents and 65 publications (Table 1.1), contributed to the eleven factors of the literature review (table 1.2) developed specifically for risks of natural hazards . The influential relations of all eleven factors were ordered in a scatter diagram. To answer the first sub-question and analyze concepts and definitions, enablers and constraints, descriptions, challenges, and opportunities were analyzed for each of the main factors (research and knowledge, stakeholder involvement, communication, decision making, and adaptation to rapid changes). In the discussion the same factors are analyzed in the study case context.

Table 1.1 Quantity of existing documents and sources for "risk governance"

	Google Scholar	Science Direct	Scopus	Springer	UN documents	IRGC documents	Total used publications
2005-2015	718	403	343	376			
2005-2015 with filters*	561	56	78	67	1	12	48 (35+1+12)
2015-2018	481	340	235	286			
2015-2018 with filters*	379	91	98	96	1	3	34 (30+1+3)

*Filters applied by excluding documents related only to: "finance", "economics", "industry", "toxicology", "epidemiology", "medicine", "industrial production", "energy", "materials", "nanotechnology", "computer sciences", "food control" or "chemicals"

1.4.1 Risk Governance factors

Before 2015, from the 48 publications on risk governance studied, 19 were based on or exemplified by case studies, ten of them in Europe and none in South America. Most of the publications analyzed all types of natural risks; some of them considered only floods, landslides, or even volcanoes. The methodology most used after the literature review and analysis was interviews, in some cases focus groups and workshops were included. The selected variables were registered in a quantitative inventory, selecting the variables most considered in all 48 papers. Beyond the central elements of appraisal, management, and communication, other elements were found that were directly related to the frameworks addressing dynamic environments studied (table 1.2). Research and knowledge were included in the majority of the definitions, followed by stakeholder involvement and communication. All drivers, challenges, and variables presented in the IRGC official documents (n=12) and other frameworks released after 2005 (n=35) were related to the eleven previously selected factors and described according to the different authors' definitions. Table 1.2 presents the number of times a factor was named in IRGC official definitions and other documents. A description used by these sources to define or break down these factors was included. In the discussion (chapter 6), the most mentioned factors are further described and contextualized for dynamic environments and the case study in Brazil.

Table 1.2 Most considered factors in "Risk Governance" publications and description of the eleven factors of RG frameworks

Main factors described in publications	Variables in publications	IRGC+UN Documents	Variables in publications	IRGC + UN Documents	Total Variables	Total Variables	Description and definitions of each factor
Year and n-value	**2005-15 n=35**	**2005-15 n=13**	**2016-19 n=26**	**2016-19 n=4**	**2005-2015**	**2016-2019**	
Communication	29	11	5	3	**40**	**8**	Considered as a main factor for trust building and common understanding that helps integration. Requires considering communication channels, language, completeness, asymmetries, spaces for communication, perception and participation among others.
Research and knowledge	21	21	5	1	**42**	**6**	Used to evaluate of the situation, collecting feedback, formal and informal knowledge and experience. Requires considering complexity, scientific uncertainty, socio-political ambiguity, time management (when is it enough?), scientific unknowns, the gap between information and knowledge, space and time, traceability, technological advances and others.
Power and empowerment	9	3	1	1	**12**	**2**	Measured as the authority and the capacity to influence others. Requires taking into account conflict of interest, influence level, trust, credibility, political and population pressure among others.
Perception	11	12	5	1	**23**	**6**	As awareness and own concept of risk. Requires considering risk prioritization, pre-estimation,

Main factors described in publications	Variables in publications	IRGC+UN Documents	Variables in publications	IRGC + UN Documents	Total Variables	Total Variables	Description and definitions of each factor
Year and n-value	**2005-15 n=35**	**2005-15 n=13**	**2016-19 n=26**	**2016-19 n=4**	**2005-2015**	**2016-2019**	
							screening and framing, acceptability, ambiguity, concerns of consequences and others.
Vulnerability	6	5	1	1	**11**	**2**	As susceptibility and coping capacity. Requires considering socio-economic defining factors, positive feedback, varying vulnerabilities, tolerability and others.
Political system	9	12	14	1	**21**	**15**	As the political interaction for different functions in a government. Requires considering pressure, political culture, controversy, regulatory basis, political economy, science and policy interface among others.
Stakeholder involvement	21	15	18	4	**36**	**22**	As the participation of all involved in the decision-making process. Requires considering social dynamics and conflicts, reflective processing, participation, associations, informal support, networks, social network analysis and others.
Adaptation	14	5	7	2	**19**	**9**	As capacity of adjustment. Requires considering flexibility, immediate response, knowledge, participation, planned and autonomous adaptation among others.
Decision making	7	8	5	1	**15**	**6**	As selecting a course of action. Requires considering management options, perception, evidence based, risk-based, short and long term among others.
Implementation	8	11	4	1	**19**	**5**	As accomplishing a plan or a decision. Requires considering time adjustment, location, performance, management and others.
Complexity	2	9	2	2	**11**	**4**	As hard to analyze or sole. Requires considering path dependency avoidance, temporal complications, recognizing complexity and others.
Others	0	5	4	0	**5**	**4**	Transparency, safety margins, scale, spatial planning, environmental sustainability, ecosystem-based DRR, jurisdiction, perverse incentives, malicious motives and acts, availability, organizational capacity and others.

To analyze RG frameworks, this research mainly considered the official documents released, starting with the IRGC white paper no 1, "Risk Governance - Towards an Integrative Approach" (2005) and "An introduction to the IRGC Risk Governance Framework" a follow-up and corrected version (2008). Ortwin Renn and Katherine Walker (Renn and Walker, 2008b) re-assessed the original framework through lessons learned, presenting conceptual issues and showing that it can be used on critical elements as broad conceptual guidance. Later, two official documents were released, "The Emergence of Risk" (IRGC, 2010b) focusing on new risks or risks apparent in new or unfamiliar

conditions, and "Risk Governance Deficits" (IRGC, 2009) designed to better understand causes and prevention/mitigation measures. This study identified failures constraining overall effectiveness in structures and processes that failed again due to one of the main criticisms made in 2008 about the extreme separation of the management sphere from the appraisal sphere. Some problems identified in this publication were related to the fundamental understanding of risk (Aven, 2011), while variation in time and difference between socio-political and environmental spheres were not so evident. It recognized the importance of adaptability in environments that are uncertain and dynamic. It was not until 2012 that the IRGC proposed an actual way to improve public sector governance in emerging risks. Based on six case studies, it developed nine drivers of effective public sector governance of emerging risks (IRGC, 2013).

Andreas Klinke, together with Ortwin Renn, released an article in the Journal of Risk Research that proposed a model that augments the IRGC classical model of 2005, recognizing the necessity for constant renovation (Klinke and Renn, 2012). It included a new approach with a pre-estimation process, followed by a rotational process of interdisciplinary estimation, characterization, evaluation, management, and monitoring and control (Renn et al., 2011). Although the concept of DE was not mentioned, "continuous and gradual learning and adjustment" (Klinke and Renn, 2012, p.278) was added to handle complexity. In the reflective processing of the IRGC, an assessment of the risk tolerance versus potential benefit was suggested, a case not applicable for natural hazards. The frameworks presented are not successfully established in cases of natural risks that are non-linear. In cases where linearity is not given, high complexity and uncertainty are also characteristic. Lindell and Perry presented short- and long-term responses as time concepts for DRR. Even if the border was not so well defined, long-term responses are complex and require more interest and attention from the Possible Affected People (PAP) that is translated into agreements in their social environment (Lindell and Perry, 2004a). To address interdisciplinary risk estimation, the German Advisory Council on Global Change (WBGU) proposed ubiquity and persistence related to geographical and temporal scale, respectively. A physical environment (space) and a temporal approach (time) are feeble. Temporal and spatial scales are most common in environmental sciences, but lack a common definition, especially in the social sciences (Gibson et al., 2000b); (Müller-Mahn, 2013). For instance, the expanded IRGC framework and the modified version of Klinke and Renn included more spatial dimensions at all stages. In the first chapter of "The spatial dimension of risk", Klinke and Renn adopted a construction of two different views of space, a basic one is taken as a "reference to a physical entity to which humans can relate" and a more complex one related to a "construction of associations that various actors link to space and its dimensions" (Müller-Mahn, 2013, p.2). The definition of the scale is, in this case, not as important as the consideration of it as a dynamic environment (continuous spatial and temporal changes) for continuous work.

1.4.2 Results: influential relation of RG factors

Analyzing the factors and their relationships according to susceptibility and influence, two main clusters of factors appear. Decision making (DM), implementation, and adaptation are very susceptible and easily influenced by other factors, while power and empowerment, stakeholder involvement, and communication have the most influence on other factors (Figure 1.7). All influential factors may be the key to better work in risk governance and may more effectively improve the results of DM implementation and ultimately adaptation.

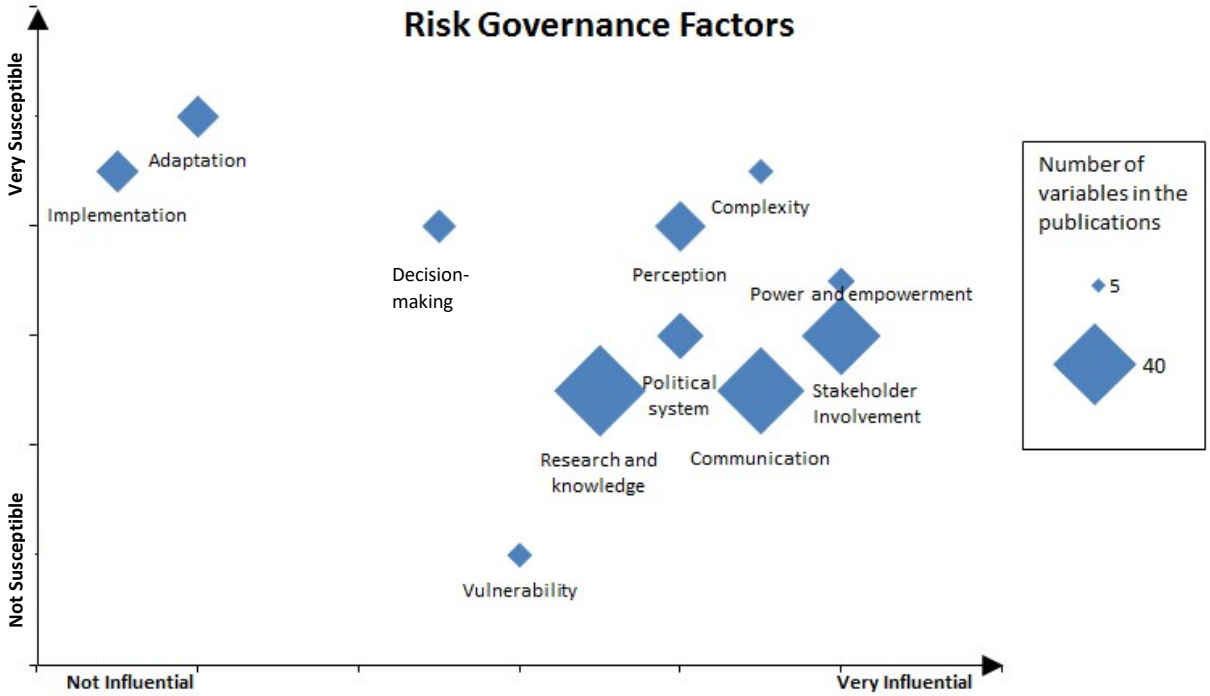


Figure 1.7 Factors interrelation of influence and susceptibility

A rotational process has already been suggested in the IRGC framework and the corrections. To have a positive change in adaptative capacity, an improvement spiraling around communication was suggested. Communications led by stakeholder involvement and empowerment is a central and leading factor that ideally increases over time. Monitoring and control phases should define differences to previous states and establish future desired outcomes. Decision-making, implementation, and, therefore, adaptation should evolve as the environment does.

To analyze these factors, assess how these concepts are applied, and the potential of them requires a great deal of work in the field. Hence, these factors were taken to the research area and further explored among the perceptions of the stakeholders. Also, to explore the possible development of risk governance in the area, these factors are presented as a starting point.

Chapter references

Adams, Cristina; Rodrigues, Sidney T.; Calmon, Miguel; Kumar, Chetan (2016): Impacts of large-scale forest restoration on socioeconomic status and local livelihoods. What we know and do not know. In *Biotropica* 48 (6), pp. 731–744. DOI: 10.1111/btp.12385.

Ares P, Risler J (2013) Manual de mapeo colectivo. Recursos cartográficos críticos para procesos territoriales de creación colaborativa. Buenos Aires: Tinta Limón BBC (2011) Brazil flood and mudslide deaths rise as rescue goes on – BBC News.Barkan, Steven E. (2012): Social Change and the Environment. Chapter 20. Maine.

Birkmann, Jörn (Ed.) (2013): Measuring vulnerability to natural hazards. Towards disaster resilient societies. 2. ed. Tokyo: United Nations Univ. Press.

Burch S., Gupta A., Y.A. Inoue C., Kalfagianni A., Persson A., Gerlak A.K, Ishii A., Patterson J., Pickering J., Scobie M., Van der Heijden J, Vervoort J, Adler C, Bloomfield M, Djalante R et al (2019) New directions in earth system governance research, Earth System Governance, Elsevier, January 2019

Bustillos Ardaya, Alicia; Miranda, Javier; Cho, Minjung (2015): Global umbrella for local rains: Assessing implementation of the Hyogo Framework for Action in Rio de Janeiro, Brazil. In *World Water Week Conference* 25.

Canejo, Andressa (2015): Nº de vítimas em tragédia no RJ pode ser 10 vezes maior, dizem entidades. Globo. Available online at http://g1.globo.com/rj/regiao-serrana/noticia/2015/08/entidades-apontam-subnotificacao-de-vitimas-da-tragedia-de-2011-na-serra.html, checked on 7/22/2016.

Cardona, O.D.; van Aalst, J.; Birkmann, M.; Fordham, G.; McGregor, R.; Perez, R.S., R.S. et al. (2012): Determinants of Risk: Exposure and Vulnerability. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA,. Available online at https://www.ipcc.ch/site/assets/uploads/2018/03/SREX-Chap2_FINAL-1.pdf.

Coelho-Netto, Ana Luiza; Avelar, André S.; Fernandes, Manoel C.; Lacerda, Willy A. (2007): Landslide susceptibility in a mountainous geoecosystem, Tijuca Massif, Rio de Janeiro. The role of morphometric subdivision of the terrain. In *Geomorphology* 87 (3), pp. 120–131. DOI: 10.1016/j.geomorph.2006.03.041.

Cohen, Yehudi A. (1983): A theory and a model of social change and evolution. In *Journal of Anthropological Archaeology* 2 (2), pp. 164–207. DOI: 10.1016/0278-4165(83)90011-9.

Custódio, Aline; Corrêa, Talita (2012): Tragédia na Região Serrana teve mais mortos que o divulgado. EXTRA. Available online at http://extra.globo.com/noticias/rio/tragedia-regiao-serrana-2011/tragedia-na-regiao-serrana-teve-mais-mortos-que-divulgado-5685873.html, checked on 7/22/2016.

de Ven, Andrew H. Van; Aldrich, Howard E. (1979): Organizations and Environments. In *Administrative Science Quarterly* 24 (2), p. 320. DOI: 10.2307/2392504.

Dess, Gregory G.; Beard, Donald W. (1984): Dimensions of Organizational Task Environments. In *Administrative Science Quarterly* 29 (1), p. 52. DOI: 10.2307/2393080.

dos R. Pereira, Donizete; Martinez, Mauro A.; Pruski, Fernando F.; da Silva, Demetrius D. (2016): Hydrological simulation in a basin of typical tropical climate and soil using the SWAT model part I. Calibration and validation tests. In *Journal of Hydrology: Regional Studies* 7, pp. 14–37. DOI: 10.1016/j.ejrh.2016.05.002.

Ferreira, Luiz Claudio (2016): "Pior enchente" do Rio de Janeiro completa 50 anos. EBC. Available online at http://www.ebc.com.br/noticias/meio-ambiente/2015/12/pior-enchente-do-rio-de-janeiro-completa-50-anos, checked on 9/28/2016.

GFB (2012): Plano Nacional de Gestão de Riscos e Resposta a Desastres Naturais. Brasilien.

Gibson, Clark C.; Ostrom, Elinor; Ahn, T.K. (2000): The concept of scale and the human dimensions of global change: a survey. In *Ecological Economics* 32, pp. 217–239.

GITEC / IP/ CODEX REMOTE (2013): Concepção do arranjo Institucional e operacional para a gestão de risco de desastres no estado do Rio de Janeiro.

IBGE (2010): Banco de dados socioeconomicos.

IBGE (2017): Estadistica dos estados. Available online at http://www.ibge.gov.br/estadosat/perfil.php?sigla=rj, checked on 1/16/2017.

IPCC (2012): Managing the risks of extreme events and disasters to advance climate change adaptation. Special report of the Intergovernmental Panel on Climate Change. With assistance of Christopher B. Field. Geneva: IPCC. Available online at http://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf.

IRGC (2005): Risk Governance. Towards an integrative approach. With assistance of Ortwin Renn, Peter Graham. Geneva.

IRGC (2013): Public Sector Governance of Emerging Risks. Hallmarks and drivers. Workshop report.

Klinke, Andreas; Renn, Ortwin (2012): Adaptive and integrative governance on risk and uncertainty. In *Journal of Risk Research* 15 (3), pp. 273–292. DOI: 10.1080/13669877.2011.636838.

Lawrence, Judy; Reisinger, Andy; Mullan, Brett; Jackson, Bethanna (2013): Exploring climate change uncertainties to support adaptive management of changing flood-risk. In *Environmental Science & Policy* 33, pp. 133–142. DOI: 10.1016/j.envsci.2013.05.008.

Marengo, José A. (2014): O futuro clima do Brasil. In *Rev. USP* (103), p. 25. DOI: 10.11606/issn.2316-9036.v0i103p25-32.

Ministério da Educação (2018): Catálogo de Teses & Dissertações - CAPES. Available online at http://catalogodeteses.capes.gov.br/catalogo-teses/#!/, updated on 1/17/2018, checked on 6/30/2018.

Moreira, Francisco; Fontes, Inês; Dias, Susana; Silva, Jorge Batista e.; Loupa-Ramos, Isabel (2016): Contrasting static versus dynamic-based typologies of land cover patterns in the Lisbon metropolitan area. Towards a better understanding of peri-urban areas. In *Applied Geography* 75, pp. 49–59. DOI: 10.1016/j.apgeog.2016.08.004.

Muller-Mahn, Detlef (2013): The Spatial Dimension of Risk: How Geography Shapes the Emergence of Riskscapes. Routledge. Abingdon Oxon. ISBN 9781138900943

Nehren, Udo; Schlüter, Sabine; Raedig, Claudia; Sattler, Dietmar; Hissa, Helga (2019): Strategies and tools for a sustainable rural Rio de Janeiro. Cham, Switzerland: Springer (Springer series on environmental management).

Netto, Ana Luiza Coelho; Sato, Anderson Mululo; Souza Avelar, André de; Vianna, Lílian Gabriela G.; Araújo, Ingrid S.; Ferreira, David L. C. et al. (2013): January 2011. The Extreme Landslide Disaster in Brazil. In Claudio Margottini, Paolo Canuti, Kyoji Sassa (Eds.): Landslide Science and Practice. Volume 6: Risk Assessment, Management and Mitigation. Dordrecht: Springer (Landslide science and practice, v 6), pp. 377–384.

OECD (2009): OECD Global Science Forum. Applications unanticipated consequences and unrealized opportunities. Paris.

Ostrom, Elinor (2008): Frameworks and theories of environmental change. In *Global Environmental Change* 18 (2), pp. 249–252. DOI: 10.1016/j.gloenvcha.2008.01.001.

Pachauri, R. K.; Mayer, Leo (Eds.) (2015): Climate change 2014. Synthesis report. Intergovernmental Panel on Climate Change. Geneva, Switzerland: Intergovernmental Panel on Climate Change.

Pereira, Eder Johnson de Area L, Silveira Ferreira, Pualo J, de Santana Ribeiro Luis C, Carvalho,Hernane, Terciane S, Borges de Barros Pereira (2019) Policy in Brazil (2016–2019) threaten conservation of the Amazon rainforest, Environmental Science & Policy, Elsevier

Pereira E. Johnson de Area L, de Santana Ribeiro Luiz C, da Silva Freitas Lucio F., Borges de Barros Pereira H (2020) Brazilian policy and agribusiness damage the Amazon rainforest Land Use Policy, Elsevier

Reed, Mark S.; Graves, Anil; Dandy, Norman; Posthumus, Helena; Hubacek, Klaus; Morris, Joe et al. (2009): Who's in and why? A typology of stakeholder analysis methods for natural resource management. In *Journal of environmental management* 90 (5), pp. 1933–1949. DOI: 10.1016/j.jenvman.2009.01.001.

Reid, Walter V. (2005): Ecosystems and human well-being. Synthesis : a report of the Millennium Ecosystem Assessment. [Place of publication not identified]: [publisher not identified].

Renn, Ortwin; Walker, Katherine D. (2008): Global risk governance. Concept and practice using the IRGC framework. Dordrecht, the Netherlands: Springer (Book series on global risk governance, 1).

Rice M., Henderson-sellers A. (2012): Chapter 18 Future Climate One Vital Component of Trans-disciplinary Earth System Science: Elsevier (Book series The Future of the World's Climate)

Rowley, Jennifer (2007): The wisdom hierarchy. Representations of the DIKW hierarchy. In *Journal of Information Science* 33 (2), pp. 163–180. DOI: 10.1177/0165551506070706.

Sohi, Ravipreet S. (1996): The effects of environmental dynamism and heterogeneity on salespeople's role perceptions, performance and job satisfaction. In *European Journal of Marketing* 30 (7), pp. 49–67. DOI: 10.1108/03090569610123816.

Schewe Jacob, Heinke Jens, Gerten, Dieter; Haddeland, Ingjerd; Arnell, Nigel; Clark, Douglas; Dankers, Rutger; Eisner, Stephanie; Fekete, Balázs; Kim, H.; Liu, X.; Masaki, Y.; Portmann, F.; Satoh, Y.; Stacke, T.; Tang, Q.; Wada, Y.; Wisser, D.; Albrecht, T. (2013) How climate change will exacerbate global water scarcity, EGU General Assembly 2013, held 7-12 April, 2013 in Vienna, Austria, id. EGU2013-11770

Steffen, W. L.; Eliott, Susannah (2004): Global change and the earth system. A planet under pressure : executive summary. Stockholm, Sweden: IGBP Secretariat.

Strassburg, Bernardo B. N.; Barros, Felipe S. M.; Crouzeilles, Renato; Iribarrem, Alvaro; Santos, Juliana Silveira dos; Silva, Daniel et al. (2016): The role of natural regeneration to ecosystem services provision and habitat availability. A case study in the Brazilian Atlantic Forest. In *Biotropica* 48 (6), pp. 890–899. DOI: 10.1111/btp.12393.

Tian, Li; Ge, Biqing; Li, Yongfu (2016): Impacts of state-led and bottom-up urbanization on land use change in the peri-urban areas of Shanghai. Planned growth or uncontrolled sprawl? In *Cities. DOI:* 10.1016/j.cities.2016.01.002.

Turchin, Peter; Grinin, L. E.; Korotaev, A. V.; Munck, Victor C. de (2006): History and Mathematics. Historical dynamics and development of complex societies / Edited by Peter Turchin, Leonid Grinin, Andrey Korotaev, Victor C. de Munck. Moskva: URSS.

UNESCO (2001) Statistical Yearbook, UNESCO, Paris, 68 and 65, Chap. 5. Available online at https://stats.oecd.org/glossary/detail.asp?ID=2312

UNISDR (2015): Global Assessment Report on Disaster Risk Reduction. Making development sustainable. The future of disaster risk management. Geneva: United Nations (Global assessment report on disaster risk reduction, 4.2015).

Universidade Federal de Santa Catarina (2012): Capacitação Basica em Defesa Civil. Available online at http://www.mi.gov.br/documents/10157/402604/Capacita%C3%A7%C3%A3o+B%C3%A1sica+em+Defesa+Civil+-+Livro+do+curso+em+Ambiente+Virtual+de+Ensino-Aprendizagem+-+2+Edi%C3%A7%C3%A3o.pdf/64ae64bb-c9a8-4287-b194-bec93fea3049?version=1.0, checked on 9/23/2016.

Webster, Douglas (2002): On the Edge: Shaping the Future of Peri-urban East Asia. Available online at http://APARC.stanford.edu.

Wijbenga, Frits H.; van Witteloostuijn, Arjen (2007): Entrepreneurial locus of control and competitive strategies – The moderating effect of environmental dynamism. In *Journal of Economic Psychology* 28 (5), pp. 566–589. DOI: 10.1016/j.joep.2007.04.003.

World Bank (2012): Avaliação de Perdas e Danos. Inundações e Deslizamentos na Região Serrana do Rio de Janeiro - Janeiro de 2011. Available online at http://mi.gov.br/pt/c/document_library/get_file?uuid=74dde46c-544a-4bc4-a6e1-852d4c09be06&groupId=10157.

Wright, James D. (2015): International encyclopedia of the social & behavioral sciences. Second edition. Amsterdam: Elsevier.

SECOND CHAPTER (WORKSHOP PRESENTATION)

2 Assessing implementation of the Hyogo Framework for Action in Rio de Janeiro, Brazil

Global umbrella for local rains[1].

Alicia Bustillos Ardaya, Minjung Cho, Javier Miranda Arana

Abstract

Two significant agreements targeting international development and disaster risk reduction (DRR) – the Millennium Development Goals (MDGs) and Hyogo Framework for Action (HFA) – are due to end in 2015. Thus, the debate on "next steps forward" has been on the rise to jointly address different development goals. This research assessed to what extent was the implementation of HFA in Brazil successful. The case study in Rio de Janeiro showed that disaster infrastructure reconstruction projects, policy changes, information, network and investments were success indicators. This study contributes to the debate through identifying potential challenges to implement HFA in Brazil. Information was gathered through a literature review of documents from the UNISDR, the Brazilian government, private institutions and the national progress report on the implementation of the Hyogo Framework. Semi-structured interviews were held with the main authorities working on the DRR sector of Rio de Janeiro: INEA, DRM, CPRM, SEDEC and CEMADEN. A matrix was developed to compare all indicators of every priority of action of the HFA with actions observed in the case study. This case study identified gaps in the implementation of the HFA and highlighted the importance of local level implementation and capacity building. For setting designated institutions for DRR actions, and bringing DRR at the national agenda, there weren't enough financial resources, communications networks, and long-term goals to be rooted at the local community level. The current HFA fell short on guiding local governments to set appropriate administrative actions. Gaps were found in technological capacity, resources' use issues across all HFA actions, implementation specially at the local level. Policy design was found to be the fastest and least expensive step forward in the national policy process of DRR. The time investment and financial costs deemed to hold back the transition into policy implementation at the state and local levels. Strengthening disaster preparedness at all levels and reducing underlying factors (4th and 5th HFApa), were harder to realize since it is difficult to reach local levels in Brazil. In addition to understanding of barriers and enablers of implementation, more research is needed to assess outcomes brought by the implementation of the global initiative such as the HFA.

Keywords: Disaster Risk Reduction · policy implementation · post-Hyogo Framework for Action · vulnerability · interdisciplinary research

[1] SIWI Stockholm International Water Institute | Presented in the World Water Week 2015, Workshop: Managing change - strengthening resilience to climate and disaster risks
www.siwi.org | https://programme.worldwaterweek.org/Schedule/Detail/5156

2.1 Introduction – Timing the debate

Disaster risk itself directly impacts progress of development and poverty. As a result of the increase in natural disaster losses, policymakers, practitioners, and members of the research community around the world are seeking effective and efficient means of minimizing disaster risk. During this process two significant agreements on international development and disaster risk reduction – the Millennium Development Goals (MDGs) and Hyogo Framework for Action (hereinafter, 'HFA') – are due to end in 2015. As 2015 approaches many development goals converge and the debate on "next step forward" has been on the rise (Development of the post-2015 Framework for DRR - Third UN World Conference on Disaster Risk Reduction (WCDRR)). But the fundamental question is the following: Are global frameworks agreed among nations making progress? Through implementing HFA will the disaster risks and losses be reduced? This question should be addressed when nations are considering another ten year commitment for the successor of the global frameworks and when the future frameworks are in debate (Lavell, et al., 2013).

Significant advances have been made through 2005-2015 HFA such as early warning systems, disaster risk reduction (DRR) as a development concern, and common framework for coordinated effort (Development of the post-2015 Framework for DRR - Third UN World Conference on Disaster Risk Reduction (WCDRR)). However, there are gaps and concerns that need to be addressed about the current HFA before moving forward to the post-2015 DRR agreement (the 'HFA2'). Global discussions continue to address these gaps, increase accountability of the framework agreement, and create a linkage among climate change and post 2015 development agenda (post-MDG).

For a nation, despite the commitment and implementation efforts for DRR once disaster strikes relief efforts and mitigation can be inadequate. Although various theoretical constructs such as frameworks are beneficial to assess the disaster phenomenon and the means of minimizing losses, the disaster risk reduction process becomes less effective if theory and practice are set apart from one another. This research aims to assess the implementation of HFA in Brazil through case study of disaster infrastructure reconstruction projects, policy changes, information, network and investments in Brazil and Rio de Janeiro. This case study aims to shed light on the implementation challenges of HFA and realistic capacities that need to be met to commit to such framework. Ultimately, this study hopes to contribute to the post 2015 debate by analyzing the major challenges on the implementation of the HFA Background.

2.1.1 Hydrological disaster

In the last decades studies show that there has been increasing number of disasters and disaster impacts all over the world. Over the past four decades disasters resulted in mortality of 3.3 million and economic losses of 2.3 trillion million dollars (Kunreuther, et al., 2003). Of these disasters, hydrological disasters account for most occurrences, damages, and victims in natural disasters (Guha-Sapir, et al., 2012). Hydrological disaster is defined as "events caused by deviations in normal water cycle and/or overflow of bodies of water caused by wind set-up" (Guha-Sapir, et al., 2012) which the main type is defined as flood. Sources of flood water can arise from the sea, from glacial melt, snowmelt or rainfall and from ground infiltration. Flooding also result from failure of man-made water containment systems such as dams, reservoirs and sewage pumping systems. Based on the definition

of IPCC SREX report, types of floods include "river (fluvial) floods, flash floods, urban floods, pluvial floods, sewer floods, coastal floods, and glacial lake outburst floods" (IPCC, 2012).

In most cases floods occur when excess water interacts with natural and human-made environments in a negative sense, causing damage, death and disruption. Studies have shown factors related to such disaster are due to increase in population, urbanization in flood-prone areas, and expansion of property value (Peduzzi, et al., 2009). The global trend of floods clearly illustrates the connection between highly concentrated population and flood reporting. Both absolute and relative exposures to different types of flood risk vary considerably between countries (Kundzewicz, et al., 2014). Therefore, reviewing the changing flood risk and regional aspect of floods in the case of Brazil is important to examine disaster risk reduction strategies' effectiveness.

2.1.2 Brazil Flood Disaster

The Latin American region, in the case of Brazil, is no exception to this phenomenon. According to World Bank, Brazil was believed to be disaster-free country (Brazil: A plan to manage disasters could save money for development). However, in 2008 in Santa Catarina, floods and landslides killed about 110 people and damaged the Bolivia-Brazil gas pipeline. In Alagoas and Pernambuco the worst rainy season in the last 20 years happened in 2010, which affected approximately 1 million people in two of Brazil's poorest states. Meanwhile in 2011 in Rio de Janeiro, a series of flash floods and landslides claim the lives of 1,000 people in seven cities of the mountainous region of the state. Then over 100,000 people were left homeless and key infrastructure was destroyed. Thus, increases in the frequency and severity of flood events are making flood risk prevention a top priority. A recent economic assessment, the first of its kind conducted after the four disasters, estimates the total cost to be as much as US$9 billion (The World Bank, 2012).

Case of Rio de Janeiro, Brazil

Rio de Janeiro state is not a novice when it comes to leadership in the disaster response. The state first established the country's civil defense authority and institutionalized a disaster response program for the citizens since the massive flooding and landslide event in 1966 (Campanaro, et al., 2014). However, the state went through transitions in economy and institutional capacity during the same period when Brazil's capital moved from Rio de Janeiro to Brasilia. When the capital shifted, state lacked capacity in following the industrialization throughout the country but the economy recovered after the discoveries of offshore fossil fuel and investment in tourism. The growth in economy however did bring detrimental effects on the urban landscape of the state, particularly the capital, where the urban poor settled in unregulated and unplanned favelas in high-risk areas, including flood zones and steep mountainsides prone to landslides (Campanaro, et al., 2014). The state has growing population with high levels of urbanization on the mountains surrounding the city along with extreme soil compression caused by new livestock activities in the rural areas. Due to these changes no water is absorbed by the soils which wash over concrete, cement and gravel to flood lower elevations, resulting in more frequent flash floods during extreme rainfall events. Therefore, it is no surprise when the 2011 disaster struck, Rio de Janeiro's flash flood is considered to be the worst disaster in Brazilian history. In the city of Nova Friburgo 166mm of rainfall - more than 70% of the historical average for the month of January - caused landslides (CAPRA, 2012). Various organizations - Civil Defense, municipalities, state governments, National Public Security Force - were involved to operate in the post-disaster management since more than five municipalities - Areal, Bom Jardim,

Nova Friburgo, Sao Jose do Vale do Rio Preto, Sink, Petropolis and Teresopolis – announced a state of emergency. The disaster impacts were not only limited to both economic and livelihood damages, but also raised a concern in risk management policies and disaster in the country. Immediately after the rains, the response process, President Dilma Rousseff installed a task force and began a long process of strengthening risk management practices and disasters nationwide.

Institutional setting for DRR in Brazil and Rio de Janeiro

There are various national and state institutions working on DRR in Brazil, for monitoring, preparedness, resilience and response at all levels. The main institution working on DRR at local level in many municipalities is Defensa Civil (DC). This institution is in charge of the alarm activation, rapid response and evacuation of the population, as well as to prepare the population for disasters. SEDEC is the state secretary of civil defense that organizes and administers DC in every municipality and reports it to CEMADEN. CEMADEN is the federal center for natural disasters monitoring and alert reporting to Defensa Civil. For providing with response activities in reconstruction and liberation of pathways, the state secretariat for works (SEOBRAS) is the first in line. Similarly, Rio Rural (another state agency working on rural areas) is in charge of response activities like funds for farmers and recovery of productions. Water resource monitoring (river level and rainfall) at the state level is in charge of INEA, the state secretary for environment and the national water agency at a federal level. The geologic service (DRM) creates different types of risk maps for different municipalities on the state and the mineral resources research center (CPRM) has a national database of geological data, both of them, CPRM and DRM linked to the ministry of energy and mines.

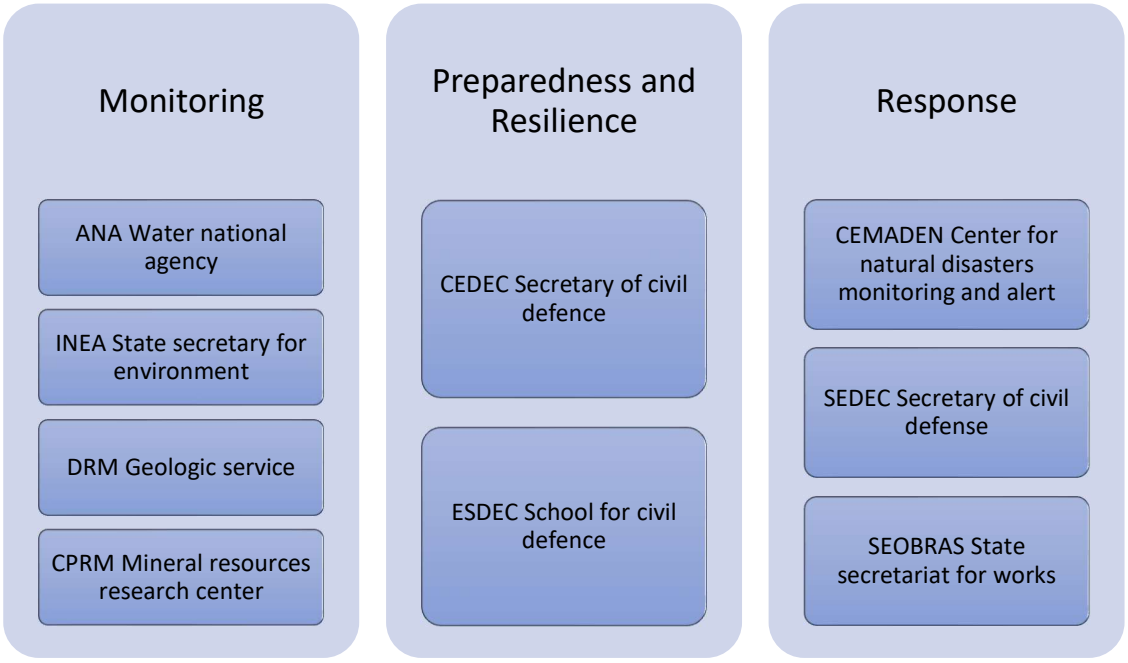


Figure 2.1 Institutional arrangement for DRR in Rio de Janeiro (based on official information)

2.1.3 What is Hyogo Framework for Action (HFA) and its implementation in Brazil

The World Conference on Disaster Reduction (WCDR) was held in Kobe, Hyogo, Japan to create a global framework on disaster risk reduction efforts for 2005-2015. The ultimate goal of this blueprint was to reduce disaster losses by 2015 – in lives, and in the social, economic, and environmental assets of communities and countries (Hyogo Framework for Action (HFA) - UNISDR). This framework was agreed upon 168 countries to reduce risk and to create a common system of coordination. The HFA provides five priorities for action and offers guiding principles and practical means for achieving disaster resilience.

The HFA is the reflection and lessons learned from the previous effort in disaster risk reduction – Yokohama Strategy. The Yokohama Strategy was a guideline for prevention, preparedness, and mitigation and its plan of action developed in 1994. Although it was considered back then as the milestone in disaster risk reduction it also brought challenges and gaps in ensuring a more systematic action to address national and local capacities for disaster risk reduction in the context of sustainability. Therefore, the WCDR held in 2005 aimed to give a more action-oriented guideline toward building local capacity for DRR, enhancement in resource allocation and management for DRR, and to address the gaps and challenges from the Yokohama strategy – governance, risk identification, knowledge management, reducing risk, reducing risk, preparedness (UN/ISDR, 2014). These areas later became the key priorities for HFA and have been translated as the five areas for priorities of action.

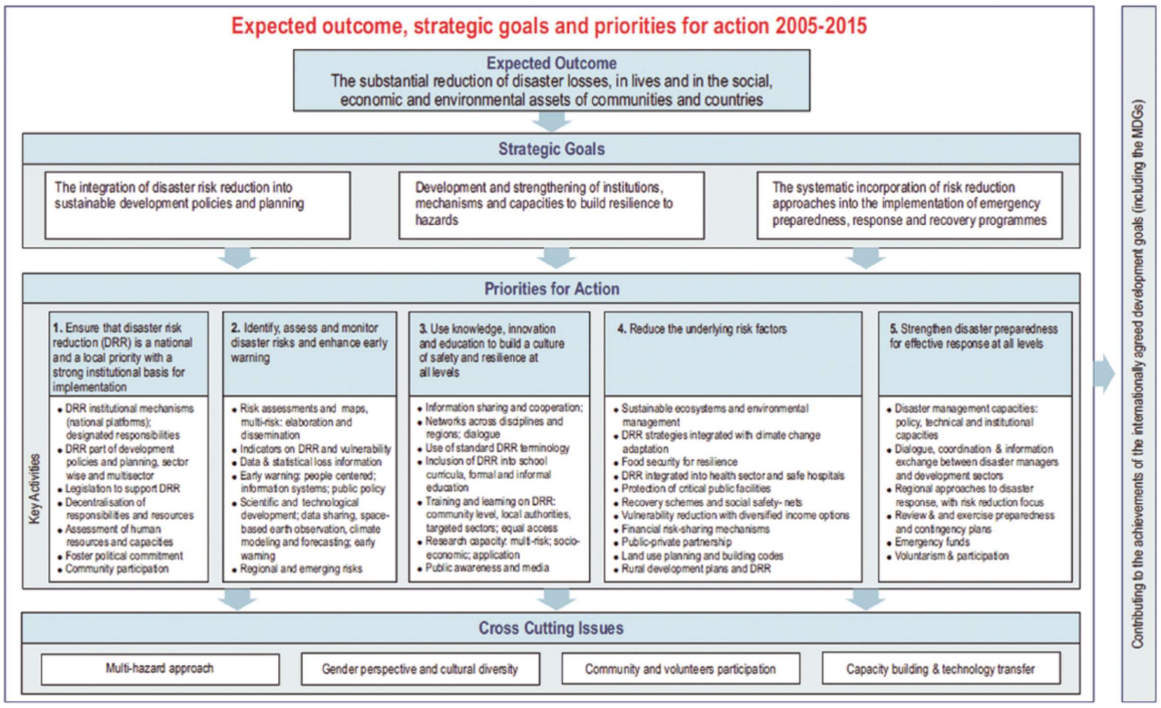


Figure 2.2 HFA's outcomes, goals and priorities (UN/ISDR, 2007)

Since the HFA was created, Brazil has reviewed the national disaster law taking into account the HFA (UN/ISDR, 2006). The country has shown comprehensive progress in specially Priority action 1.

National policy and a legal framework for disaster risk reduction exist with decentralized responsibilities and capacities at all levels by setting up legislation to focus on prevention of disaster. Brazil's National Plan for Disaster Risk Management was introduced in 2012 which entailed the construction of huge reservoirs to control the flow of flood water into the rivers, thus reducing the risk of inundation. Based on the policy briefs the rhetoric of the national plan does seem to follow the HFA (Hansson, et al., 2008). Brazil has been considered one of the active countries for HFA Monitor tool participating in at least one cycle of the HFA Review since 2007 (Hyogo Framework for Action (HFA) - UNISDR).

2.2 Conceptual Framework

Disaster risk reduction aims to both reduce the probability and strengthen a system's ability to deal with a vulnerable situation. A vulnerable situation is defined as "the vulnerability of a system's attribute(s) of concern to a hazard (in temporal reference)" (Füssel, 2007 p. 157). Vulnerability in the context of the United Nations International Strategy for Disaster Reduction (UN/ISDR, 2004 p. 16) refers to "the conditions […] which increase the susceptibility of a community to the impact of hazards". Moreover, this concept in a more comprehensive approach includes not only susceptibility but also exposure, coping capacity and adaptive capacity, within physical, social, economic, environmental and institutional dimensions (Birkmann, 2007). A human-centered system is a common way to assess vulnerability (see for example Guha-Sapir et al. (2012)); however, some broader definitions of a system recognize the inter-connected relationship between people, communities, society, economy and nature (Birkmann, 2007) (Oxley, 2013). Attributes of concern refer to the valued attributes of the system analyzed which are threatened by the system's exposure to a hazard (Füssel, 2007). Turner II et al. (2003) distinguished two types of hazards depending on their temporality of occurrence as discrete (i.e. perturbations) or continuous (i.e. stress or stressors). As mentioned in the previous section, in Rio de Janeiro, discrete hazards (i.e. floods and landslides) are of particular interest as they bring consequences to the system (in its different dimensions) both in the short- and long-term.

Rio de Janeiro's capacity to mitigate, prepare and respond to hydrological natural disasters and adjust and adapt to changing circumstances bring important challenges. Natural disasters directly affect economic development, sustainable development, environmental degradation, and intensifying poverty; hence, leaving human and natural systems in poorer levels (Tran, et al., 2007 p. 275) after exposure to a natural extreme event. Keating et al. (2014) identify that flood mitigation measures are a cost-effective policy strategy to reduce flood damage. Furthermore, prepare and response properties of a system help develop its coping capabilities; meanwhile, adjust and adapt properties shape its absorption capabilities (Oxley, 2013). Strategies to deal with disasters can be classified in structural and non-structural actions. Structural actions include dams, barriers and channel all which need great investments. Non-structural actions include non-tangible measures like awareness contingency plans and communication systems (Thampapillai, et al., 2008).

Implementations of actions meant for mitigation, prevention, and response to a hydrological disaster are critical in achieving desirable states of risk reduction. Therefore, it is important to identify barriers and enabling elements that affect implementation of the HFA's priorities of action. Nikitina et al. (2011) identified eight processes that influence implementation of best practices (BP) in the context

of water resource management. These dimensions are interrelated within a social-ecological system and shape how strategies are developed, how multiple interests are coordinated, how stakeholders are involved and how is the development of capacities realized.

Based on Nikita et al.'s framework, the present work examines which processes are considered within a socioeconomic-ecological system that affect implementation of the HFA within the state of Rio de Janeiro in Brazil. To do so, the processes were clustered in three different elements that drive implementation. First, technical elements of implementation, such as a comprehensive information on hazards or information on economic instant and long-term impacts, requires technical capacity of staff in governmental national, regional and local institutions. Likewise, an effective warning system needs technology and communication network available and accessible to society, especially amongst the more vulnerable.

A second element regards financial, fiscal and economic structures. Monetary resources must be available to develop any strategy or policy to deal with extreme events. Further, the activities in which the economy is based (e.g. natural resource use) and its dynamics could foster or decrease implementation (Benson, 2004). While international aid can play an important role for implementation, we expect Brazil, as an important emerging economy, to be self-sufficient.

A third element to consider is related to administrative/institutional elements. An institutional environment such as laws, regulations, policies and traditional practices must ensure that natural resources' use, economic activities and power structures work together towards a sustainable development coupled with DRR. Furthermore, administrative bodies must be flexible enough to respond to an extreme event, as well as prepared to reduce vulnerable situations in a socioeconomic-ecological system. Figure 2.3 represents the conceptual framework utilized in this research. It shows how the elements of a socioeconomic-ecological system interact to enable or posed challenges for implementation of the HFA.

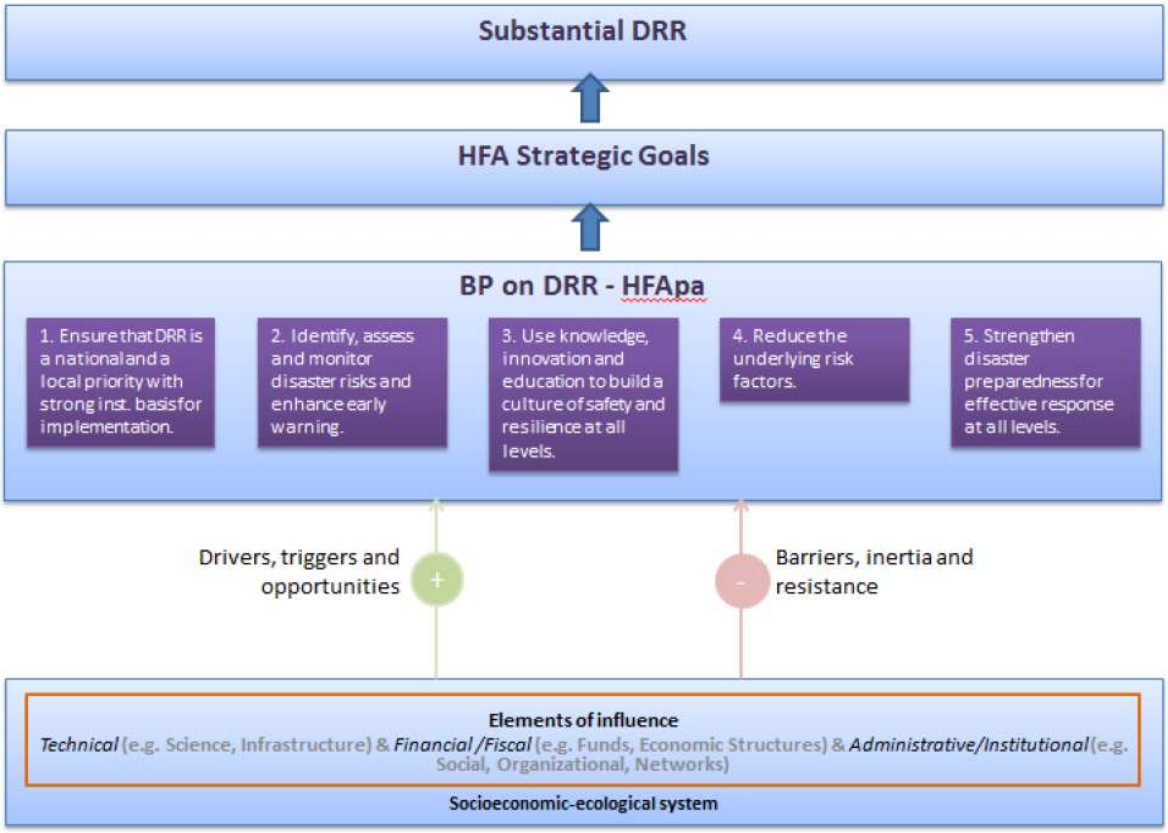


Figure 2.3 Elements that affect implementation of the HFApa (adapted from Nikitina et al., 2011) [21]

2.3 Problem Statement and Central Research Question(s)

As mentioned above, Brazil has been subject to hazardous threats and in the mountainous area of the State of Rio de Janeiro particularly those of hydrological nature. Such threats have pulled the country to adopt a strategy to deal with negative effects of natural disasters for almost a decade. Moreover, since the existence of the HFA, Brazil has been engaged in its implementation. Yet, recent natural disasters like flash floods and landslides in municipalities such as Teresópolis, Petrópolis and Nova Friburgo caused severe aftermaths on social, economic and environmental systems.

Since the 2011 floods, Brazil has increased efforts to deal with such events. A first impression would be that the country is now on the path to reduce the probability of a vulnerable situation and to improve its capacity to deal with it when present. But such expected outcomes won't be realized if the best practices proposed by the HFA are not materialized. This brings into the discussion a general research question: *To what extent has Brazil, particularly in Rio de Janeiro, implemented the HFA's priorities for action (HFApa)?*

Our general research question can be tackled from different perspectives. One can look at actions realized, outputs produced or outcomes achieved. The scope of this research will focus on the first perspective in a higher degree and the second and third on a lower degree. Such strategy was decided mainly for two reasons. First, we obtained most of the information from secondary data (see Methods

section for a better explanation). This reason also excluded the possibility to compile and analyze a sound database from which some econometric estimation, model, and/or simulation could be derived; nevertheless, the secondary information was complemented with interviews made by the authors with relevant stakeholders. Second, DRR is meant to systematically mitigate impacts against an extreme event not only on the short- but also on the long-term; it would be difficult to assess at this point in time all the outcomes expected from the HFA.

Based on Rio de Janeiro's case, this work hypothesized that there exist certain processes that create barriers or opportunities to fully implement the HFA. Moreover, the likelihood of implementing each priority recommended by the HFA depends on the amount of time and resources needed in practice. Therefore, to achieve a fully successful implementation of the HFA, it is crucial to identify the elements that enable or challenge it. Thus, one sub-question is *to what extent are the barriers or enabling factors that affect the HFApa's implementation?* Barriers and enabling elements related to HFApa's implementation are classified in this study in three different but interrelated categories: i) technical; ii) financial/ fiscal; and iii) administrative/ institutional. For the identification of relevant measures, an overview of current practices was done both at a national level and within the state of Rio de Janeiro. To address the proposed sub-question this research will try to answer three more specific questions:

1) Which are the technical elements that enable or challenge the HFApa's implementation in Brazil and Rio de Janeiro?
2) Which are the financial/fiscal elements that enable or challenge the HFApa's implantation in Brazil and Rio de Janeiro?
3) Which administrative/institutional elements enable or challenge the HFApa's implantation in Brazil and Rio de Janeiro?

2.4 Methods

The literature review was based on official documents from the UN/ISDR, which were used as base and guideline to code the information in different indicators. The indicators were divided in three main groups; social, economic and environmental. Three secondary groups were created to capture interrelation(s) across indicators. The secondary groups are socio-environmental; socio-economic; and economic-environmental aspects. The national progress report on the implementation of the HFA, created for 2011 to 2013, adds information by reporting the level of progress of all core indicators in the priorities for action given from the UN. To complement the information of the framework, documents created by the Brazilian government and different institutions on the new organization of the DRR sector were needed and added to international literature addressing those changes and the different aspects taken in the HFA.

For the comparison and validation of the information given on the documents, semi-structured interviews were held with the main authorities working on the DRR sector of Rio de Janeiro: INEA, DRM, CPRM, SEDEC and CEMADEN. In this way, perceptions from relevant stakeholders were extracted. A matrix was developed to compare all indicators of every priority of action of the HFA with actions done in reality in the case study. This matrix, fed by the indicators explained above, is compared and analyzed in the quest to find barriers or enablers of implementation. The actions considered were reported by the federal government of Brazil and then compared with the information obtained from interviews with stakeholders in Rio de Janeiro. Additionally existing

documents within relevant institutions were revised. Finally, an interdisciplinary analytical strategy was made to interpret the information The interpretation is shaped by the conceptual framework. Thus on one side, it aims to close the gap of general disaster knowledge, in which the lack of a holistic analysis prevents effective risk management (Cardona, 2004). On another side, recognizing diversity will bring balance between an ineffective fragmentation and the ideal of a holistic perspective (Bankoff, et al., 2014 p. 197).

2.5 Results

The analysis of the HFA revealed issues that were not addressed such as environmental and technical aspects, while other areas such as political and social were more pronounced. There are 125 key questions and means of verification within the five priorities of action of the HFA, 68 of them (55%) are directly related to socio political issues. Adding the socio-economic and socio-environmental aspects a total of 89 items (72%) was identified. On the other side there are only 11 (9%) key questions and means of verifications directly related to environmental issues.

64 key questions and means of verification (51%) are reported to be accomplished by 2015; however there is a lot to be analyzed in terms of quality. The reports are simplified to a series of accomplished/not accomplished qualifications that describe quantitatively the level of progress on the application of the framework, we developed a qualitative analysis of the enablers (triggers) and challenges (barriers) identified for every priority of action (PA).

2.5.1 Action 1: Ensure that DRR is a national and a local priority with strong institutional basis for implementation.

This action focuses on creating a legal platform for the implementation of the framework from a national level accomplished by the creation of laws for DRR. In Brazil, a national plan was created, together with regular law-enforced budget allocation for local governments. Moreover, contingency plans were finalized. Nevertheless, great differences in information quality and information quantity are to be identified within the actual contingency plans created by different municipalities to address national plans. Despite that the definition of the Oxfam cited by the UNISDR includes systems, procedures, standards, human resources and communications (Mondal, 2005); the municipalities' contingency plans are focused on a description of the standard actions to be taken in each of the state-case reported by the information portal of the environmental agency of the state.

The allocation of resources needed to accomplish the first priority of action is structurally different from the common practice to assign resources in Brazil. There is no national budget assigned for risk reduction and relief itself, instead, there is a forecast budget to cope with an extreme event used for short-term operational considerations.

One key element of implementation for this priority action is the participation of civil-society organizations within a national multi-sectorial platform for DRR. On the documents revised no such platform exists. Additionally, participation of communitarian projects at a municipal level is considered limited (Azevedo, 2013). For greater inclusion of municipalities in the DRR platform and for more community participation, donations are given to the poorest municipalities to buy basic kits while the NUDECs (Community Nucleus for Civil Defense) are being created or strengthened (Teixeira, 2014).

2.5.2 Action 2: Identify, assess and monitor disaster risks and enhance early warning.

The national standards for hazard risk assessment are coordinated by one central agency as recommended by the HFA. The information system of INEA, CEMADEN and ANA are available online and are open-access to every citizen for dissemination. The information of these monitoring systems is being constantly updated.

Despite the description focused on "identification and monitoring", this action has only two means of verification from the HFA (out of 26) mentioning monitoring, most of them are on communication, participation and assessment. The Global Water Partnership (GWP) offers entire guides for Flood Risk Monitoring and identification depending on the type of flood and there are documents and trainings given from the Japan International Cooperation Agency (JICA) in Brazil about land-movements and risk mapping that has to be consulted for these purposes3.

There is a developed monitoring network in Brazil, this network for rainfall and water level is highly concentrated in the south-east. The national water Agency (ANA) has more than 2.500 rainfall and 1.800 pluviometric stations installed in the whole country. Yet ANA's and other state agencies stations are usually placed where the political and economic power is highly concentrated.

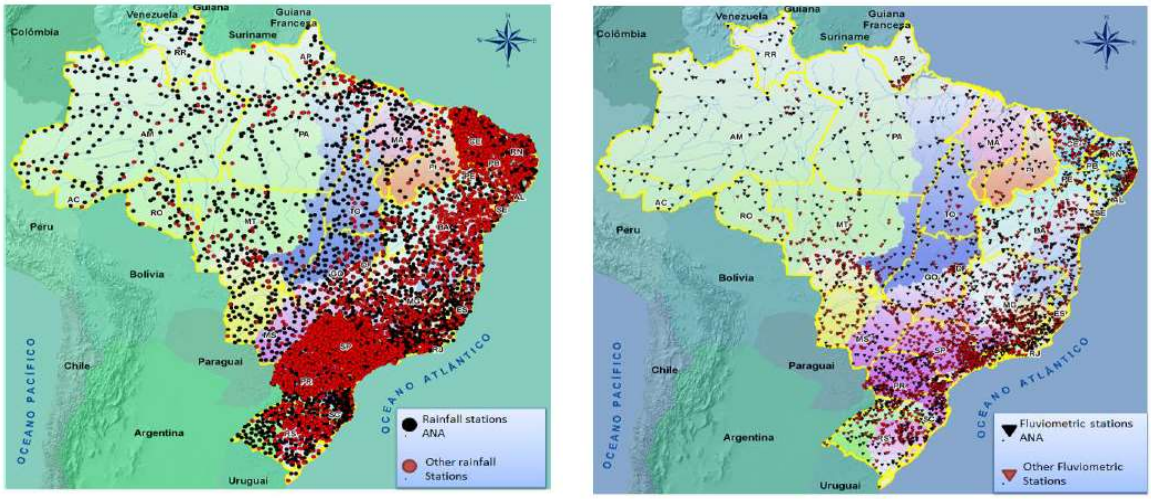


Figure 2.4 Rainfall (left) and Pluviometric (right) stations in Brazil installed by ANA and other institutions (ANA, 2014).

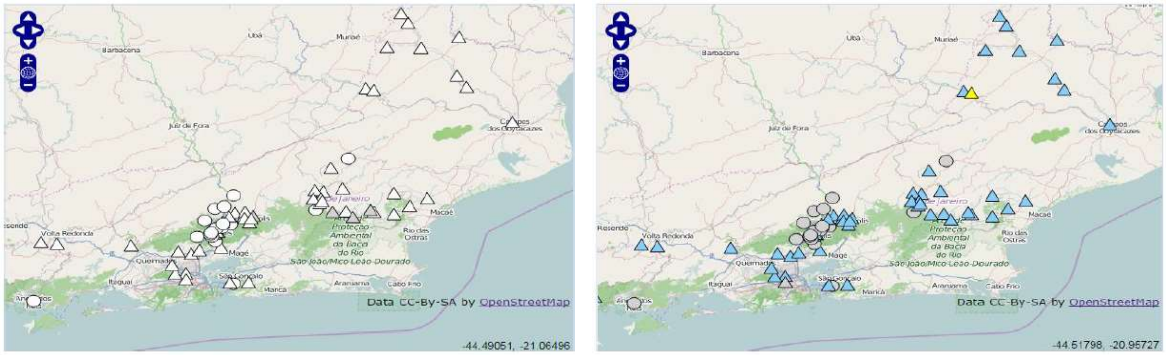


Figure 2.5 Rainfall (left) and Pluviometric (right) stations installed in Rio de Janeiro (INEA, 2014).

INEA for instance, has most of its stations concentrated in the main and most populated cities of the State, in the city of Rio the Janeiro and the three main cities of the mountainous area (16 Stations), leaving the northern area with low density of stations.

A proper modelling system for disaster forecasting is not yet being applied. Although monetary resources are there, the INEA agency from Rio de Janeiro state, for instance, is looking for an external consultant agency to develop this system (Avellar, et al., 2014), while CEMADEN the state agency for civil defense is exploring the idea to develop one by themselves (Kempers, 2014). INEA has an early warning system based on the changes on rainfall and water level that are reported as yellow and red alarm in case they exceed standards (Avellar, et al., 2014).

Transboundary risks and watershed management has not been taken into account as they are not perceived as a policy priority by Brazil or its neighbors. Since there is a low population density within border areas; there has been little focus to address potential vulnerable situations. A similar case is to be seen in the state of Rio de Janeiro, sharing the Paraiba do Sul watershed with two other states, one of them being the state of Sao Paolo a high population density state and Minas Gerais. The AGEVAP works in the Paraiba do Sul basin, one of the few transboundary institutions for water management in Brazil. The lack of transboundary institutions at federal and state levels represents a barrier of implementation that increases the likelihood of conflicts on water allocation and management.

2.5.3 Action 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels.

The information is highly advance and widely available. ANA has created in 2005 an open information system for hydrological data from Brazil (ANA, 2005) which displays information on level gauges, as well as climatological data. However, the greatest change on the information system in the state of Rio de Janeiro was given by INEA through a real-time flood information system (INEA). This system stores and displays real time information on water level and rainfall state-wide; and differentiates changes in levels of river and rains across space to identify extreme events. In 2013 the S2ID webpage (Defesa Civil Brasil, 2013) was released by the CEDEC. This website aims to create an integrated system of disaster information, where stakeholders find geospatial data on previous disasters and important information on requirements to be subject of relieve funds.

There has not been a concrete inclusion of DRR education in school's curricula, while public awareness is in a developing process. An example of awareness campaigns in the state of Rio de Janeiro is given by ESDEC. This institution is conducting short courses simulations and capacity building trainings in major cities. However, participation in the first simulation organized by Defensa Civil, in 20 neighborhoods of Nova Friburgo State, had a low level of participation (approx. 5 persons per neighborhood). One reason is that many people living in affected areas were already participants in many other initiatives for disaster aid (Kempers, 2014).

2.5.4 Action 4: Reduce the underlying risk factors.

INEA develops and implements mechanisms to address protected areas, payment for ecosystems services and recently projects for climate change adaptation. In 2013, Rio Rural released a new campaign towards the 2016 Olympic Games. This campaign focuses on spring protection for water

availability. Moreover, it represents an enabling financial element which compensates landowners to keep the forest intact in their spring areas. By November 2014, 1170 springs were protected (Rio Rural, 2013). Even though the main focus of these actions is not directly aimed for DRR, they are indirectly contributing to this objective.

The reduction on the vulnerability on the social sector still needs many improvements on insurance and guarantee schemes (i.e. risk transfer), but has great international recognition on relief through monetary transfers (Azevedo, 2013). The infrastructure investment on human settlements is high once an area has been declared as a risk prone area (based on past events). The main investments are on slope stabilization, infrastructure recovery and re-housing projects (Ikemoto, 2014). Despite the debate on re-housing projects effectiveness, "minha casa minha vida" is an example of a rehousing project from 2009, investing almost R$ 1,168 billion (US$ 458938.38 Dollars) with more positive than negative outcomes that is also helping families to get out of risk prone areas (Ikemoto, 2014).

Risk mapping in Brazil is made by the CPRM while in the State of Rio de Janeiro is done by DRM who creates the maps of imminent and remnant risk. DRM's mapping is done for each municipality. Land zoning and regulation is an independent task done by the municipalities and depends on their particular resources and priorities. Most municipalities have problems with this application because they lack financial resources "know how" and administrative cooperation (Lima, 2014).

2.5.5 Action 5: Strengthen disaster preparedness for effective response at all levels.

In terms of strong policies and programs, Brazil is ahead of other Latin countries. Yet, the roles of institutions had to be specified more than once despite the existence of policies addressing most actions recommended in the HFA.

Based on the assessment of DRR strategies, only the major risk prone areas are taken into account, leaving most of the municipalities behind in technology access, investment and capacity building activities. The monitoring system of CEMADEN is only installed in 15 municipalities (16%) of Rio de Janeiro state (Kempers, 2014). Contingency plans vary extremely from municipality to municipality, in order to affirm that every one of them is in place to deal with major disaster at all levels more information is needed (Teixeira, 2014). Shelter installation, rescue teams capacitation and operation and communication centers are centralized in the mountainous area (Kempers, 2014).

Figure 2.6 below summarizes the results found on this research. Moreover, it shows the relationship amongst the priorities of action through the process of reaching DRR. The main enablers and challenges given in Brazil for the accomplishment of the priorities of actions described above are also summarized in this graph. The major strength of DRR implementation process in Brazil is in its technological and institutional capacity which enables development and investments in reconstruction and protection for DRR. However, most of these efforts are concentrated in economically stable or growing municipalities rather than most vulnerable areas. Also, the priorities of action are depicted in a sequence which assumes that the last processes may be more costly from a technological, financial or institutional level and may take more time, personal and work to reach a local level. These costs postpone and weaken the full implementation of some actions.

Based on the interviews of relevant stakeholders, HFA missed certain aspects of what entails to be implemented, and decision- and policy-makers are not fully aware of it. Hence, the Brazilian government needs a more comprehensive understanding of DRR to develop and implement contingency plans effectively.

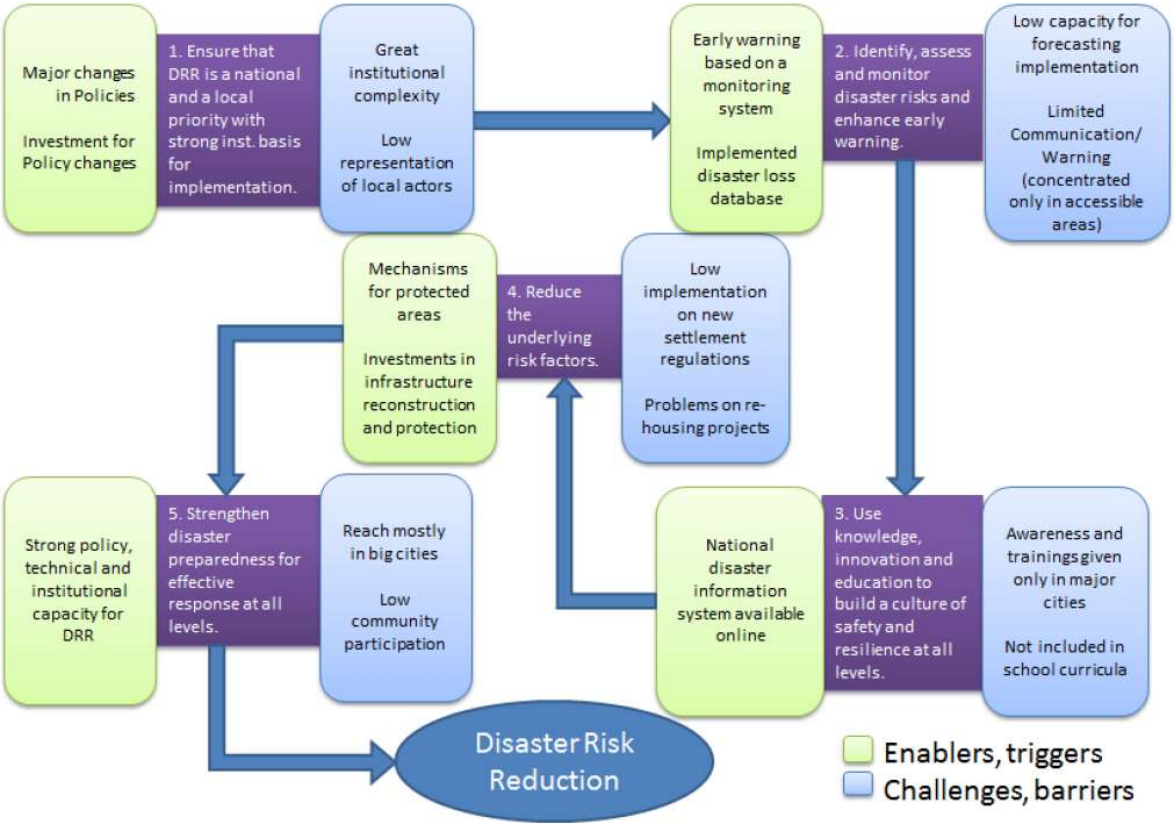


Figure 2.6 Barriers and enablers identified in Brazil and Rio de Janeiro (based on the HFA priorities of action)

2.6 Discussion

Based on our results we here analyze the actions taken in Brazil and Rio de Janeiro by comparing them with the elements proposed in this study as key to fully implement the HFApa.

2.6.1 Technical elements

As mentioned above in the results Brazil has its most significant early warning system ANA which delivers early warning services for risk weather and climate events. Brazil has committed personnel and departments working on analysis and quantification of impact in the most up to date scientific manner which presents as an opportunity to further implementation of HFApa. However, despite having the system in place for monitored information, the early warning systems and programs are stagnant in raw information that is not processed to forecasting systems and is then underappreciated. The most plausible explanation for this is that information is not accessed by or communicated to small local governments and communities. There is a bottleneck along the line where disaster risk reduction implementation is hampered. The case of 2011 and 2010 disasters

showed that such information was not disseminated down to local levels which affected vulnerable population and ended up in mass casualties. The problem results in not knowing the significance of risk. This is due to the fact that there is more significant focus on response. The actions are taken after the disaster rather than knowing before what the disaster risk is at the local level. This technological gap in implementation results in communities being exposed to high risk levels due to lack of knowledge.

Information dissemination seems to be a major issue since there is no effective communication between people who are affected by disasters (community) and the people who know that disaster occur (government). The information is not being utilized or shared between both groups. This lack of cooperation and communication between government and community represents a barrier of implementation for HFApa 3. One of HFApa 3, having a disaster risk reduction strategy in school curricula is important to create awareness among communities and future generations. Survival skills such as swimming or being aware of the danger signals of landslides are good examples on how to advance on this challenge at school level. These measures may increase the resilience of the population and should be seen as future technical investments that will deliver sustainable outcomes in the long run. Sporadic visits to schools for DRR education realized currently in the state of Rio de Janeiro must be part of a long term planning.

2.6.2 Financial/Fiscal elements

Based on the analysis it is clear that although there are many organization and departments directly or indirectly assigned for DRR, they do not have a fully committed and functioning disaster management unit at all levels along with lack of cooperation (all states, all municipalities). One contributing element for this is that there is only provisional short-term post-disaster financial support rather than long term commitments.

Another problem concerning budgeting is bureaucracy. Bureaucracy in the case of Rio de Janeiro is having various responsible bodies for DRR which results in more procedures and complexity in getting financial resources. It then reduces funds for different disaster management actions bringing inefficient and belated disaster management in general. The fundamental problem may be the lack of urgency and preparedness at local level. This is due to the fact that at local level the budget may be limited, there are too many requirements for extra budget request and other matters take precedence over disaster risk management.

2.6.3 Administrative/Institutional elements

The way that the current DRR is structured, the complexity of the institutional arrangement and the overlapping tasks in Rio de Janeiro brings in the question: who is responsible for what? Responsibilities of the different agencies and unclear jurisdiction brings in confusion and assumptions that only municipalities, officially declared as affected, are responsible for disaster risk reduction and must initiate disaster management actions at the local level. This may hamper further implementation process of HFA since municipalities not officially declared under risk, lack clear jurisdiction in taking responsibilities or initiatives of disaster risk reduction by their own. This may be due to lack of resources and/or disaster risk prevention/management capacities. Another aspect of the administrative/institution barrier are (frequent) major changes of existent policies or existent of contradictory objectives across policies.

A classic example of this is the land use and resettlement policy such as “minha casa minha vida”. Rio de Janeiro is a growing urbanization state with a high economic growth in the oil, cement and tourism sector, but has growing unregulated favelas[4] as well. Even though preventing housing and development on risk prone areas through laws seem effective (Deyle, et al., 2008) reality is much more complex. This is due to variety of factors including: lack of techniques in assessing flash-floods/landslide risk prone areas, laws are not being enforced (costly) or being enforceable (difficult to operationalize), and lack of funds for implementation, and lack of government agencies’ coordination (at different levels). Instead of frequent changes in policies, proper land use planning and incorporating disaster risk assessment in favelas and disaster prone human-settlements could have prevented the massive effects of landslide and flash-flood disasters.

2.7 Conclusions

This case study identifies gaps in the implementation of the HFA; a point of concern for the present post-HFA debate. Rio de Janeiro is an interesting case study in the context of HFA and DRR implementation because it represents a classic example of extraneous hazard combined with preventable man-made disaster, along with implications of climate change and rapid urbanization. Therefore, this study builds on the awareness for local level implementation and capacity building to both Brazil’s decision makers and the international community (e.g. UN/ISDR).

Brazil has been remarkable in establishing a law environment, setting designated institutions for DRR actions, and bringing DRR at the national agenda. However, as shown in the case of Rio de Janeiro there aren’t enough financial resources, communications networks, and long-term goals for DRR to be rooted at a local and community levels. Likewise, dynamic administration actions, in particular regarding land use planning for reducing risk in slum areas (favelas) is a pressing issue. Unfortunately, the current HFApa falls short to enforce such laws. Without addressing them, these issues could have negative impacts on the livelihoods of vulnerable sectors of the population, both before and after the disaster.

Gaps are found in technological and resources’ use issues across all HFA actions. In terms of levels of implementation it’s clear that there are gaps in implementation more at the local level than at the state level. Relevant stakeholders interviewed at local level highlighted gaps in the HFApa’s implementation, and identified national and state level support as necessary to address this issue in the long-run.

There is a considerable period of time between designing a policy and its effective implementation in a real context. The policy design is the first, fastest and potentially less expensive action in the policy process. The transition into a policy implementation potentially increases time and financial cost. Strengthening disaster preparedness at all levels, and reducing underlying factors, more specifically the fourth and fifth HFApa (i.e. those related with policy implementation), are harder to realize since it is difficult to reach all levels and address particular local underlying factors in a country as big as Brazil.

In addition to the understanding of barriers and enablers of implementation, more research is needed to assess the outcomes brought by the implementation of the global initiative such as the HFA. Such comprehensive knowledge of risks will efficiently and effectively focus efforts to avoid vulnerable

situations for both society and nature. Further, it will offer some solutions to achieve a long-term vision of DRR from policy makers; thus securing a sustainable development that accounts for risk reduction.

Chapter references

ANA HidroWeb [Online]. - 2005. - 11 25, 2014. - http://hidroweb.ana.gov.br/.

Avellar C. and Duarte W. INEA [Interview]. - 08 20, 2014.

Azevedo V.H. National progress report on the implementation of the Hyogo Framework for Action [Report] / National Secretary of Civil Defense ; Ministry of National Integration. - 2013.

Bankoff G., Frerks Georg and Hilhorst D. Mapping vulnerability: Disasters, development, and people [Book]. - London; Sterling, VA : Earthscan Publications, 2014.

Benson C. Macro-economic Concepts of Vulnerability: Dynamics, Complexity and Public Policy [Book Section] // Mapping vulnerability: Disasters, development, and people / book auth. Bankoff G., Frerks G. and Hilhorst D.. - London; Sterling, VA : Earthscan Publications, 2004. - 978-1853839641.

Birkmann J. Risk and vulnerability indicators at different scales: Applicability, usefulness and policy implications. [Journal] // Environmental Hazards. - 2007. - 1 : Vol. 7. - pp. 20-31.

Campanaro A., Matera M. and Pedroso F. Integrated Metropolitan Planning: A Case for DRM in the State of Rio de Janeiro [Article] // insights in DRM. A Practitioner's Perspective on Disaster Risk Management in Latin America & the Caribbean. - [s.l.] : The World Bank, 2014. - 4 : Vol. 86519.

CAPRA CAPRA. Probabilistic Risk Assessment Program [Online]. - 11 09, 2012. - 11 23, 2014. - http://www.ecapra.org/dala-rio-de-janeiro.

Cardona O.D. 3 The Need for Rethinking the Concepts of Vulnerability and Risk from a Holistic Perspective: A Necessary Review and Criticism for Effective Risk Management [Book Section] // Mapping vulnerability: Disasters, development, and people. - London; Sterling, VA : Earthscan Publications, 2004. - 978-1853839641.

Defesa Civil Brasil Sistema Integrado de Informações sobre Desastres - S2ID [Online]. - 2013. - 11 25, 2014. - http://s2id.mi.gov.br/.

Deyle R.E., Chapin T.S. and Baker E.J. The Proof of the Planning is in the Platting: An Evaluation of Florida's Hurricane Exposure Mitigation Planning Mandate [Journal] // Journal of The American Planning Association. - 2008. - 3 : Vol. 74. - pp. 349-370.

Füssel H.M. Vulnerability: A generally applicable conceptual framework for climate change research. [Journal] // Global Environmental Change . - 2007. - 2 : Vol. 17. - pp. 155-167.

Guha-Sapir D. [et al.] Annual Disaster Statistical Review 2011: The Numbers and Trends [Report]. - Brussels : CRED, 2012.

Hansson K., Danielson M. and Ekenberg L. A framework for evaluation of flood management strategies [Journal] // Journal of environmental management. - 2008. - 3 : Vol. 86. - pp. 465-480.

Ikemoto M.I. State Secretary for Environment [Interview]. - 08 20, 2014.

INEA Sistema de Alerta de Cheias [Online]. - 11 25, 2014. - http://inea.infoper.net/.

IPCC Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. [Conference] // A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change / ed. Field C.B. [et al.]. - Cambridge, UK, and New York, NY, USA : Cambridge University Press, 2012.

Keating A. [et al.] Operationalizing Resilience against Natural Disaster Risk: Opportunities, Barriers, and a Way Forward [Report]. - [s.l.] : Zurich Flood Resilience Alliance, 2014.

Kempers G. CEMADEN Center for natural disasters monitoring and alert [Interview]. - 10 06, 2014.

Kundzewicz Z.W. [et al.] Flood risk and climate change: global and regional perspectives [Journal] // Hydrological Sciences Journal. - 2014. - 1 : Vol. 59. - pp. 1-28.

Kunreuther H.C. and Linnerooth-Bayer J. The financial management of catastrophic flood risks in emerging-economy countries [Journal] // Risk Analysis. - 2003. - 3 : Vol. 23. - pp. 627-639.

Lavell A. [et al.] THE FUTURE OF DISASTER RISK MANAGEMENT. An On-going Discussion [Report] : A Scoping Meeting for GAR 2015 / FLACSO/UNISDR. - [s.l.] : UNISDR, FLACSO, 2013.

Lima I. DRM Geologic service [Interview]. - 08 13, 2014.

Mondal P. “Preparedness for effective response”: Oxfam International Contingency Plan for Humanitarian Response, Vietnam [Conference] // World Conference on Disaster Risk Reduction. 20th January, 2005. - 2005.

Nikitina E. [et al.] Best Practices Guidelines and Tools for Knowledge Transfer and Implementation of Adaptive Water Governance [Report] : Deliverable No. 3.3. - [s.l.] : Twin2Go, 2011.

Oxley M. C. A “People-centred Principles-based” post-Hyogo framework to strengthen the resilience of nations and communities [Journal] // International Journal of Disaster Risk Reduction. - 2013. - Vol. 4. - pp. 1-9.

Peduzzi P. [et al.] Assessing global exposure and vulnerability towards natural hazards: the Disaster Risk Index [Journal] // Natural Hazards and Earth System Science. - 2009. - 4 : Vol. 9. - pp. 1149-1159.

Rio Rural Rio Rural 2016. Água Limpa para o Rio Olímpico [Online]. - 2013. - 11 24, 2014. - http://www.microbacias.rj.gov.br/campanha_rio_olimpico.jsp.

Teixeira J., DEC Secretary of civil defense in Nova Friburgo [Interview]. - 08 05, 2014.

Thampapillai D.J. and Musgrave W.F. Flood Damage Mitigation: A Review of Structural and Nonstructural Measures and Alternative Decision Frameworks [Journal] // Water Resources Research. - 2008. - 4 : Vol. 21. - pp. 411-424.

The World Bank The World Bank. [Online]. - 11 19, 2012. - 11 23, 2014. - http://www.worldbank.org/en/news/feature/2012/11/19/Brazil-natural-disaster-management-costs-development.

Tran P. and Shaw R. Towards an integrated approach of disaster and environment management: A case study of Thua Thien Hue province, central Viet Nam [Journal] // Environmental Hazards. - 2007. - 4 : Vol. 7. - pp. 271–282.

Turner II B. L. [et al.] A framework for vulnerability analysis in sustainability science [Journal] // Proceedings of the National Academy of Sciences of the United States of America. - 2003. - 14 : Vol. 100. - pp. 8074-8079.

UN/ISDR Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters [Report]. - Geneva : UN/ISDR, 2014.

UN/ISDR Living with Risk: A global review of disaster risk reduction [Report] : Volume I / United Nations International Strategy for Disaster Reduction . - Geneva : UN Publications, 2004.

UN/ISDR The United Nations Office for Disaster Risk Reduction [Online]. - 2006. - 11 10, 2014. - http://www.unisdr.org/who-we-are/international-strategy-for-disaster-reduction.

THIRD CHAPTER (BOOK PUBLICATION)

3 Integrated Participatory Methodologies for Disaster Risk Reduction[2]

Tools to Analyze Complex Systems Through Participatory Processes in Brazil.

Alicia Bustillos Ardaya, Mariele Evers, Lars Ribbe

Abstract

A crucial element for risk governance and disaster risk reduction in recognized international frameworks involves inclusiveness of stakeholders. Due to the dimensions of risk governance processes in Brazil, the complexity of the institutional arrangements in the state of Rio de Janeiro, and the dynamicity of the local context, a combination of different local and regional participatory methods is necessary to evaluate the participation and community-based disaster risk management that promotes it. This study describes five main participation processes applied in water-related risk areas of Nova Friburgo, Sao Fidelis, and Rio de Janeiro municipalities and implements it through combined participation methods. Exemplified focus groups and participatory workshops are described, both combining five methods: the required planning and organization, adaptation for rural and peri-urban areas, tools for an effective participatory mapping and a network analysis, digitalization of participatory maps, etc. The influences, advantages, disadvantages, and inputs of the different methodologies are analyzed and compared. Combining methods requires time, resources, and constant work; nevertheless, it helps all stakeholders understand complex systems and actively participate in decision-making. For various levels of participation, a combination of quantitative and qualitative methods allows more interaction between stakeholders and different perspectives for deeper evaluation of participation and related aspects.

Keywords: Risk governance · Participatory mapping · Exchange workshop · Cognitive mapping

[2] Springer | Springer Series on Environmental Management
U. Nehren et al. (eds.), *Strategies and Tools for a Sustainable Rural Rio de Janeiro*
https://doi.org/10.1007/978-3-319-89644-1_23

3.1 Introduction

In January 2011, floods and landslides in the mountainous region of the state of Rio de Janeiro (RJ) caused around 900 deaths and 300,000 affected people, as confirmed by official data (World Bank 2012); other sources suggest that actual losses were 8–10 times greater (Custódio and Corrêa 2012; Canejo 2015), being classified as the worse disaster in the century (BBC 2011; da Mata Siqueira 2015). Floods, landslides, droughts, and other water-related disasters are increasing problems strongly linked to poor governance, marginalization, extreme poverty, lack of infrastructure, information, and education (Adikari and Yoshitani 2009; Guha-Sapir et al. 2015; Munich Re 2016). Improving risk governance (RG) for disaster risk reduction (DRR) is a challenge that must include natural, political, and social systems in its analysis (IRGC 2010) and requires several approaches that explore diverse processes and actors (Goldin 2014). For inclusion and collectiveness, participatory approaches have proven to be very helpful in understanding, accepting, and managing complex socio-environmental systems (UNISDR), contributing constant search of additional improvements, insights, and learning for RG and DRR (Dyer et al. 2014; Vacik et al. 2014:307; Folhes et al. 2015; Hassenforder et al. 2016:504).

According to the EU Water Framework Directive recommendations (WFD 2010), public participation can be defined as "a process allowing people to influence the outcome of plans and working processes." Besides the fact that participation also implies risks and can be resource intense (Evers 2012), it can result in positive behavioral changes for all stakeholders, improving decision-making; promoting active involvement, exchange, and empowerment; building trust and commitment among them; and creating connections in the knowledge-power and management constitution (Clark-Ginsberg 2017:431). In European and North American countries,

participation methods are being applied (Evers 2012; Brown et al. 2017); however, information is needed about systematic processes and methods to be adapted for countries with local limitations and less resources. Several methods aim for better involvement of more stakeholders, but diversification of methods at implementation is recommended to better understand, model, and find solutions (Vacik et al. 2014:308). Evaluating some of the existing participatory methodologies would facilitate future planning for governmental and nongovernmental organizations in similar regions: eligibility, combination, and implementation of participatory processes.

In this chapter we present a combination of participatory methodologies to assess and promote participation in DRR processes and evaluate them with possibilities and limitations. An insight of citizens' selection, consultation, involvement, communication tools, decision-making, management, and feedback will be given,

exemplified with five main participative methods used in the field: questionnaires, interviews, focus groups (FG) including participatory mapping, timeline and prioritization exercises, and participatory workshops (PW) including a multi-voting system and product schemes. The methodologies will be cross analyzed with criteria modified from participatory approaches, but the results of the methods will not be given considering the length limitations of this chapter.

The study case area and the five main participation methods used in the field and theories will be described in Sect. 3.2. Section 3.3 will present the framework and the table with the weighted methodologies and processes and will describe the methodologies in the order of the presented criteria, defining important steps and exemplifying them with the study case. Section 3.4 will give conclusions plus further steps for new processes.

3.2 Research Area and Methods

Between August 2014 and December 2016, data was collected mainly in four municipalities in RJ (Fig. 3.1) through five main methods (Table 3.1). Semi-structured interviews for experts and authorities working at the main institutions related to DRR were the starting point and a reference for the formulation of the questionnaires. Questionnaires for population in risk areas consisted of four main parts: (1) general demographic data; (2) previous experiences with natural disasters and adopted mitigation measures; (3) risk perception, e.g., severity and likelihood; and (4) coping appraisal. Participant observation was applied during other meetings, workshops, discussions, and courses for involved stakeholders.

FG in different neighborhoods in risk areas were developed for three aspects: (1) timelines of events to introduce and encourage participation, (2) participatory mapping for georeferencing and collective construction, and (3) problem identification, voting, and prioritization to agree on main concerns related to DRR. Finally, for a systematized construction of processes and roles through dialog and information exchange between civil society and public institutions, three PW were conducted in 2014, 2015, and 2016. Main bottlenecks, overlapping and missing processes along 3 years, could be found, building examples for bottom-up and top-down approach.

A total of 26 interviews, 391 questionnaires, 11 FG, and 3 PW were conducted. In addition, 25 events around DRR were observed under the participant observation method by the first author of this study. An average of nine participants took part on each FG; most of them previously had taken part on questionnaires organized by the same team. All participants were invited to the yearly workshop (Table 3.1).

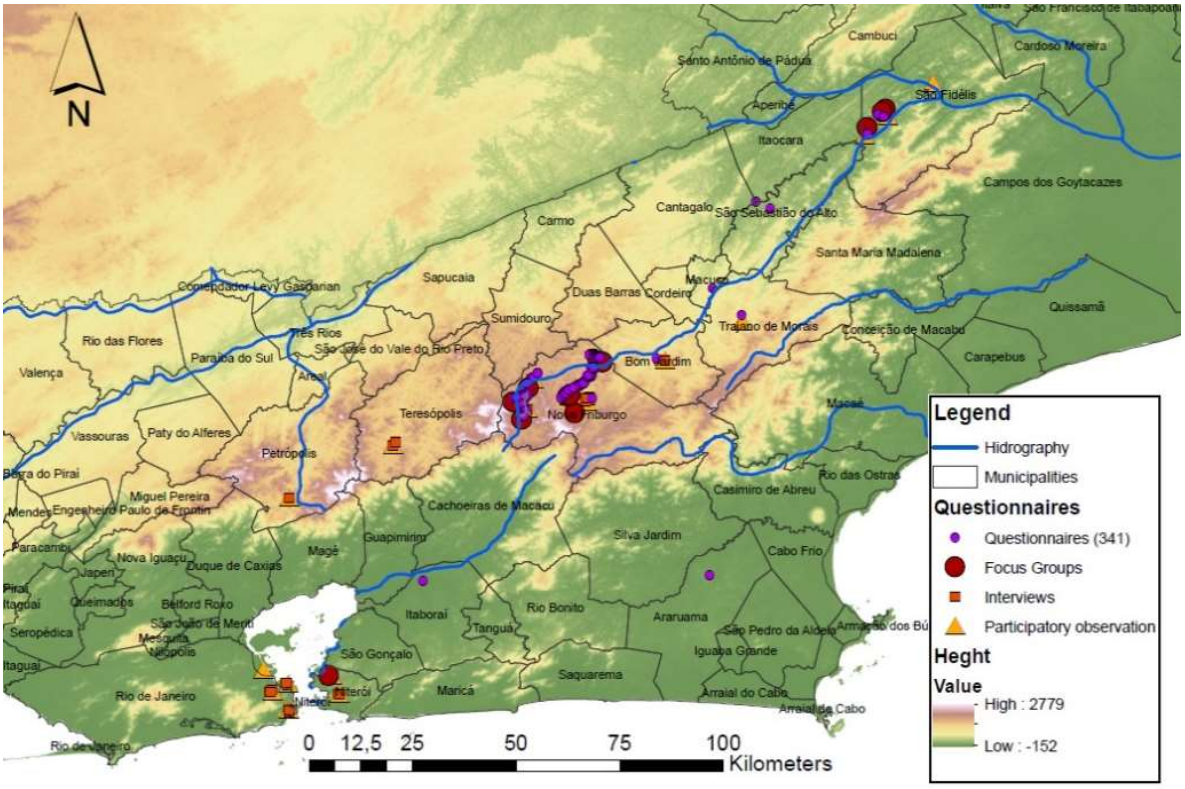


Figure 3.1 Methods used to the respective scale, purposes and scales used in the field.

Table 3.1 Description of the methods implemented

Main method	Methods used	Method theory	Quantity /Population included	Duration (each)	Planning and description
Participatory Workshops PW	Four Rs framework, Cognitive mapping, Policy exercises	(Dubois, 1998), (Eden, 1992), (Brewer 1986)	3 / 58	1 day	Contact with speakers, contact with participants, preparation of activities, etc. Cognitive structure of knowledge build in a map and divided in Rights, Responsibilities, Revenues and Relationship. Formulation of policies in the third workshop.
Focus Groups FG	Participatory mapping, Timeline, Voting and priorization	(Schensul, 2013), (Ares and Risler, 2013), (Kangas et al., 2006)	11 / 62	3 hours	Contact with the participants, elaboration and printing of maps, tolkens and preparation of the material. Collective creation of social and risk maps, local history and problem solving through priorization.
Interviews	Influence matrix, Stakeholder analysis	(Fontana and Frey, 1994), (Ulrich and Probst, 1995), (Grimble, 1998)	26 / 26	1-2 hours	Preparation of the subjects to be discussed, constant contact for appointment, confirmations and feedback. Mapping of actors and their influence, clear role of stakeholders and their connections.

Questionnaires	Questionnaire design, Q method	(Taylor-Powell, 1998), (Walonick, 2003), (Steelman and Maguire, 1999)	391 / 391	0.5-1 hour	Preparation and validation of the questionnaires, recognition of the houses under risk and repetition schedule. Main aspect for questionnaire development and data processing methods according to data taken.
Participant	Stakeholder advisory committees	Neuman (2006), Dewalt and Dewalt (2002), (McGurk et al., 2006)	25 / ~300	1 hour to 5 days	Availability for conferences, workshops and meetings, networking for information about events. Specific considerations for participant observation.

.

Above all recommendations given in the literature, the use of several methodologies requires organizational skills responding to a framework and a perspective for all interdisciplinary aspects building the criteria on which the methodologies will be evaluated.

3.3 Participation Processes

Taking communication and information, i.e., sharing and creation as a central role (IRGC 2010), four levels of participation (Evers 2012) are combined to the levels of authority and power (Fung 2006) in a loop (Fig. 3.2). In order to increase participation, benefiting individuals involved on the process and the process per se, a continuously looping system is implemented. In most of the methods presented in Table 3.1, communication is crucial and a central aspect for RG (Renn and Walker 2008). Communication tools vary from e-mails, phone calls, and even WhatsApp messages for arrangement, organizational aspects, and follow-ups to mostly direct communication for all described methods.

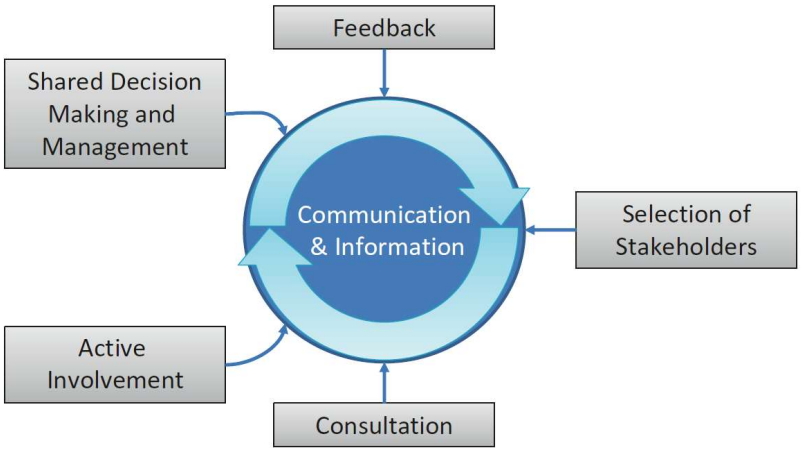


Figure 3.2 Participation looping process for diversification of methods

This continuous process diversifies methods to understand participation at various levels and to constantly select stakeholders according to availability and interests. Diverse methods had different influence on participation levels, but at the same time, participation levels influenced on the methods (Table 3.2). In this case, selection and consultation processes are mostly covered by interviews and questionnaires. Active involvement requires multilateral dialog; in FG and PW, ideas can be created, constructed, and exchanged. In order to improve shared decision-making and management, collective

understanding of the problems and dialog between population living in risk areas and decision-makers needs to be built. Feedback is crucial for constant improvement. Results, i.e., conclusions and solutions in all processes, are input for other methods. It is expected that connections and networks built grow further. In the presented case, there are specific conditions that enabled or constrained connections that will be presented in order of participation levels presented in Fig. 3.2.

3.3.1 Selecting Stakeholders

The scope of participants in questionnaires, interviews, and participant observation is embracing (general public). Besides involving more population, questionnaires are individual processes, and planning is minimized once the structure is defined. Questionnaires may be taken in several not consecutive days, and data processing may be fast and systematic. PW and FG are more exclusive, e.g., experts/representatives, and depend more on space, time, and budget possibilities. In this case, more stakeholders/participants hinder interaction and individual decision.

Table 3.2 Weighted connections between methods and participation levels in Nova Friburgo, Brazil.

How much do(es)… Contribute/influences on …	Participatory Workshops PW	Focus Groups FG	Interviews	Questionnaires	Participant observation	Selecting stakeholders	Consultation processes	Active Involvement	Shared decision ma- king & management	Feedback	Communication and Information	Trust
Participatory Workshops PW	0	3	2	1	2	3	2	3	3	1	2	3
Focus Groups FG	0	0	2	3	2	3	2	3	2	1	2	2
Interviews	0	0	0	2	1	1	2	0	0	1	1	1
Questionnaires	0	0	2	0	1	0	1	0	0	0	0	0
Participant observation	2	2	1	1	0	0	0	0	0	0	0	0
Selecting stakeholders	0	0	2	2	1	0	0	0	0	0	0	0
Consultation processes	1	2	3	3	1	1	0	0	0	1	2	2
Active Involvement	3	3	1	1	0	0	2	0	0	2	3	2
Shared decision making & mngmnt.	3	3	0	0	0	1	2	3	0	1	3	3
Feedback	3	2	1	0	0	0	1	2	1	0	3	3
Communication and Information	3	3	2	1	1	1	3	3	2	3	0	3
Trust	3	3	2	1	0	0	1	2	3	3	3	0

3 = a lot; 2 = somehow; 1 = little; 0 = nothing

In order to start with a local approach, we identified houses on risk areas near to rivers and conducted a door-to-door survey. The process required many visits at different hours to reach different population, e.g., day/night workers. At the end of the questionnaire, those surveyed were invited to a FG in their neighborhood. Response level in the study area was of 56% of the intended households to be surveyed. The most common limitation in the selection of stakeholders is a population not willing to participate. Main reasons in this case are time limitations; lack of incentives, e.g., monetary; social or perceived effectiveness on changes; mistrust on the institutions organizing and managing the mechanisms; or bad experiences with previous processes. Credibility to institutions is low; those surveyed affirmed that several non-concluded projects and visits from governmental institutions or NGOs had no visible impacts or results.

For interviews the approach was institutional, selecting main institutions working on DRR and interviewing main representatives following an official institutional arrangement (Consórcio GITEC / IP/ CODEX REMOTE 2013). After each interview, following the snowball sampling method, more contacts were collected. Every previously interviewed person enabled disposition for an interview with new contacts. In this way, state institutions will lead to local-level institutions and actors. More than 11 institutions working on DRR and representatives from the 6 local associations were interviewed after 2 cancellations and more than 15 postponements or delegations to other co-workers. All questionnaire, interview, and/or FG participants were invited to the PW held during a weekday. Although food and transport were covered for PW and FG, some representatives of civil society were not able to leave their positions for a day to attend this PW, which led to a limited representation.

3.3.2 Consultation Process

The focus of the consultation processes is to get stakeholders perception. This is characterized by medium level of interactivity and no responsibility from the stakeholder. Three documents provide an impression of consultation processes at three levels: state, municipal, and individual. The institutional arrangement organized all processes and responsibilities of main institutions working on DRR through a participation process (ConsórcioGICR 2013). In a smaller scale, before the renovation of the municipality master plan, the township of Nova Friburgo offered local consultation sessions in several neighborhoods (PMNF 2016), allowing the population to express important concerns to be considered for future development. Community meetings for consultation offered a possibility for follow-ups and participation in local projects. Nevertheless, participants complained about their suggestions not being considered, and the developers of the municipal plan complained about the suggestions being individualistic and for the sake of their own land or property. The perception of the population living in risk areas was measured through questionnaires, relating local knowledge with institutional trainings (Bustillos Ardaya et al. 2017). In individual consultations feedback and interaction are restricted, and answers are limited to or biased by predefined possibilities, yet they offer a picture of the perception, motivation, and simplified history of almost 400 dwellers.

The consultation process in semi-structured interviews developed by the first author follows a basic structure that can be managed by participants according to perceived importance and preferences. In order to get into DRR subjects, people recall previous experiences with floods and landslides (2011, 1997, 1985, etc.) and important dates in their community, e.g., when roads, electricity, or the Internet was installed, constructions, etc. This qualitative consultation process helps both the interviewed to

get into the subject and the interviewer to understand the previous dynamic experienced by individuals and collective memory in case of FG and PW. Collective consultations allow discussion about priorities and collective wellbeing. In this case, consultation process in FG is better enabled through participatory mapping that allows problems to be located and possible solutions to be geographically referenced.

3.3.3 Involvement

Involvement requires contribution of stakeholders in planning, analyzing, and solving problems (Evers 2012). Participant observation in different events related to DRR and RG allows the understanding of involvement level of institutions and organizations: dialogs between stakeholders, information sharing, and relationships among several networks. Since 2011 the constant work of DRR-related institutions with the Japan International Cooperation Agency (JICA) has created an institutional network where communication, capacity building, and participation were continuous. According to a JICA representative, although focused only in public state institutions and very centered on Japanese methodologies, all workshops, trainings, andevents organized by the JICA strengthened this network. Interviews and questionnaires can trigger analysis and questions ways of collaboration and possible solutions at an individual level. On the other hand, is collective involvement of the participants that may present a problem integrally and create discussion. Participant's selection and participation level will influence on the outcomes if stronger opinions are imposed. Participatory mapping provides advantages for involvement, and nowadays tools like GIS and Internet-based tools create high validity on perception of the population (Brown et al. 2017). Geographic information and instruments improve local work and improve decision capacity of the citizens (Usón et al. 2016). Nonetheless, involvement of local population in rural and peri-urban areas, where access to technologies and the Internet is limited, requires adaptation of existing methods. The adapted version of risk mapping can be replicated at low costs and is precise enough to be translated later to digital maps or shapefiles.

Maps for FG consisted of simplified satellite pictures of the neighborhoods printed on A0 paper sheets where only roads, houses, and river paths are visible as simple lines (Fig. 3.3). Different from suggested participatory mappings that start on blank sheets, these elements simplify location and digitization processes, making them geographically accurate. During the FG, existing elements, e.g., infrastructure, crops, springs, and problems in the area, e.g., landslides, droughts, water contamination, loss of springs, and manipulation of the river, are marked with illustrated labels and discussed. Labels simplify the process and encourage involvement: drawing or writing on the maps requires extra skills that not all participants have. Maximum water level experienced in floods and normal overflow are delineated together with evacuation routes and possible shelters. Discussion is encouraged as a promoter of involvement, information, and perception sharing in the group. Additionally, this process organizes personal ideas, shapes them collectively, and creates a product to be shared. Maps are later digitalized, made available online, printed onsite for validation, and compared to the flood risk maps created by INEA and the PMNF in nine evaluated areas using ArcGIS.

In order to encourage involvement, the observations, suggestions, and discussions during the participatory mapping should be considered for decision-making and management. Although the PW has the main goal of connecting institutions and dwellers for decision-making, by being an independent initiative, all results could only be taken as suggestions.

Figure 3.3 A0 sheets with roads, houses and rivers location (left) information being filled by the participants (right). Photos: Conrado Werneck Pimentel

3.3.4 Shared Decision-Making and Management

The third phase of the FG discusses future perspectives and simulates management, dividing it in spatial and organizational. Elements needed in the community, e.g., hoarding locations, contention walls, or water plants, are pointed and located in the map in the best possible setting. Organizationally required aspects, e.g., better contact with institutions, strengthening in groups or skills, and potentialities, e.g., courses to offer, connections with organizations, or knowledge in bureaucratic processes, are discussed, visualized, and prioritized. A voting mechanism allows participants to debate, set priorities as a group, and has a clear outcome that can be easily transmitted in workshops or meetings as processed and validated information.

In a space for dialog between local population and institutional representatives, the PW exchanged perception at local and regional scale based on a systematic vision construction method. After the presentations of local organizations and governmental institutions, processes for DRR are mapped identifying rights, responsibilities, revenues, and relationships (four R's). A multi-voting dynamic locally created (Bustillos Ardaya 2015) is implemented to allow discussion and get the collective priority of all working groups. Mixed discussion tables are built where priorities to improve DDR are individually written and rotated in the table. The received priorities are analyzed, and a priority scale is added. The meeting and divergence points are discussed, and the table must agree in five priorities. Discussion allows debate and common points between civil society and public institutions that otherwise have few opportunities for dialog.

Finally, an additional decision-making exercise is implemented: after identifying overlapping and missing processes for DRR between governmental and local institutions (Fig. 3.4), alternatives are discussed for policy development. The exercise allows stakeholders to clarify activities and products of their institution related to DRR, including inputs and outputs necessary for each institution. They

differentiate between processes before, during, and after an event (under or above the pointed line) and the outcomes for the civil society or public power (red and green cards).

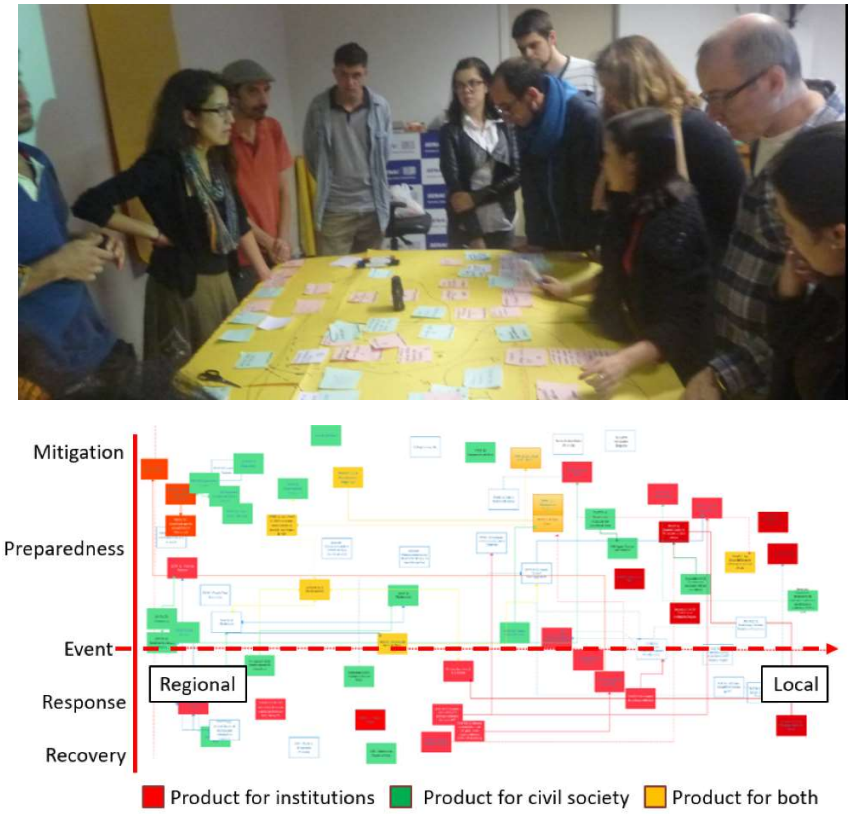


Figure 3.4: Products of institutions and organizations in Nova Friburgo (above). Workshop result (below). Photo: Conrado Werneck Pimentel

Subsequently, they connect their activities and products with the agencies/institutions/stakeholders that use them (arrows) and suggest both new uses for the data and new sources for their inputs (pointed arrows). Having a general vision of the most connected products, e.g., risk maps and prevention sites, highlighted the main necessary elements for DRR attributed to local population and attributed to public power.

Despite being a theoretical and technical approach, the PW and the FG contribute significantly to the decision-making and management, communication, and trust. As affirmed by Clark-Ginsberg (2017), placing institutional experts and local leaders ends up blurring the lines between them and between researchers and subjects.

3.3.5 Communication, Feedback, and Trust

Changing environments and solving complex problems require dialog, exchange, and deliberation to assess knowledge and causal connections in a top-down and bottom-up approach (Fekete 2012; Mauelshagen et al. 2014). Communication is a cross-subject and is related to all previously listed elements. Official documents as the US National Research Council's "Red Book" (Stern and Fineberg 1996) and the Royal Society Study Group report (Royal Society Study Group on Risk Assessment 1992)

recognize communication important for risk reduction. The Hyogo Framework for DRR (ISDR 2005) gives high priority to risk and hazard warning through communication. Furthermore, in the study case taken, it triggered social change, ameliorating multi-stakeholder understanding as Fekete describes (Fekete 2012). The dialogs during participatory mapping enhanced social identification, environmental values, in-group injunctive norms, and self-stereotypes, improving interagency coordination as Smith clarifies (Smith and Dowell 2000). In addition, during the workshops communication made decision-making more inclusive (Horita and Albuquerque 2013) and more effective (Kapucu and Garayev 2011). Innovation was also required for information diffusion of FG and PW; use of WhatsApp groups has proven to be more effective than e-mails in terms of response quantity and velocity.

Done appropriately, feedback may improve communication and build trust. Feedback should be asked at all steps and in both ways. On selection, stakeholders must be informed about the objectives, limitations, and main outcomes expected. After every consultation, involvement, and management session, it is important to ask for and give feedback and create opening spaces to update the group and closing sessions evaluating the method. Considering the several activities and concepts developed around DRR in different cities, information on the ongoing subjects, the results, and upcoming dates is important by opening every session. Feedback for FG and PW was above average, but on interviews it was clear that no big changes are expected after this kind of activities.

All methods used increase participation levels in a small scale; more work on a regular basis is required to improve these processes. Trust requires more time, constancy, resources, and involvement from all sides. Because of the duration of the field research, continuity had to be interrupted, and results could only be suggested to the government. Since limitations in time and reach were clarified to all participants at the beginning, the results are expected to vary from a governmental process. Assuring continuity and accountability of the results at a governmental level (and accomplishing it) may considerably increase trust.

3.4 Conclusions and Further Steps

Empowerment of the local population and collective decision-making is crucial in DRR, especially in complex natural and social systems like RJ. This chapter describes a series of participatory methods in five main methodologies with enablers and constrainers for participation and presents a study case where all are combined. Even when there are multiple possibilities to combine methodologies, exploring one of them illustrates the contributions of each method to the process. While participant observation, questionnaires, and interviews are better at selecting stakeholders and consulting them individually, group interactions are needed for further steps. Different activities in the focus groups and the participant workshops allow better communication and active involvement, improving the shared decision-making and therefore the management.

The consultation process in local households showed that the lack of trust on the institutions is evident. Even though the path to follow to reach visible change in DRR systems in a bureaucratic country like Brazil is long and tedious, participatory processes allow the construction of stronger networks that increase trust or reduce mistrust and improve knowledge sharing among local stakeholders. The PW allowed local stakeholders to understand the system, point on specific improvement possibilities, and through discussion understand the main concerns of institution

representatives. Although being suggestion for governmental institutions and even being time and resource intense, there is great potential in the use of these methodologies combined to increase participation: the increase of communication among stakeholders and the use of local information both for public power and research create stronger networks that contribute to the development of DRR and RG among others.

A follow-up on the study case is needed to analyze how the dynamics at bottom- up and top-down level continue to work given all externalities in the actual context. More research in methods that may contribute to empowerment of local population will allow a spectrum of possible methods for specific topics. Future case studies or methodology applications may require different adaptations on the methods. Population access to technology will define communication and working tools, knowledge will determine the translation necessity, and the frequency of the loop will be set by resources, participation willingness, and time availability. In order to increase trust and improve decision-making capacity, a closer work with decision-makers at all levels is needed. After the consultation process, the most appropriate methods should be selected according to the needs of the main stakeholders.

Chapter references

Adikari Y, Yoshitani J (2009) Global trends in water-related disasters: an insight for policymakers. International Centre for Water Hazard and Risk Management ICHARM, United Nations Educational, Paris 07 SP, France

Ares P, Risler J (2013) Manual de mapeo colectivo. Recursos cartográficos críticos para procesos territoriales de creación colaborativa. Buenos Aires: Tinta Limón BBC (2011) Brazil flood and mudslide deaths rise as rescue goes on – BBC News. http://www.bbc.com/news/world-latin-america-12180079. Accessed 16 Mar 2017

Brewer GD (1986) Methods for synthesis: policy exercises. In: Clark WC, Munn RE (eds) Sustainable development of the biosphere. Cambridge University Press, Cambridge Brown G, Strickland-Munro J, Kobryn H, Moore SA (2017) Mixed methods participatory GIS: an evaluation of the validity of qualitative and quantitative mapping methods. Appl Geogr 79:153–166. https://doi.org/10.1016/j.apgeog.2016.12.015

Bustillos Ardaya A (2015) Metodología para a priorização construtiva de elementos para a redução de riscos. Interview with Thiago Mello. Nova Friburgo RJ. Voice recorder

Bustillos Ardaya A, Evers M, Ribbe L (2017) What influences disaster risk perception? Intervention measures, flood and landslide risk perception of the population living in flood risk areas in Rio de Janeiro state, Brazil. Int J Disaster Risk Reduct. https://doi.org/10.1016/j.ijdrr.2017.09.006

Canejo A (2015) N° de vítimas em tragédia no RJ pode ser 10 vezes maior, dizem entidades. Globo. http://g1.globo.com/rj/regiao-serrana/noticia/2015/08/entidades-apontam-subnotificacao-de-vitimas-da-tragedia-de-2011-na-serra.html. Accessed 22 Jul 2016

Clark-Ginsberg A (2017) Participatory risk network analysis. A tool for disaster reduction practitioners. Int J Disaster Risk Reduct 21:430–437. https://doi.org/10.1016/j.ijdrr.2017.01.006

Consórcio GITEC/IP/CODEX REMOTE (2013) Concepção do arranjo Institucional e operacional para a gestão de risco de desastres no estado do Rio de Janeiro

Custódio A, Corrêa T (2012) Tragédia na Região Serrana teve mais mortos que o divulgado. Extra. http://extra.globo.com/noticias/rio/tragedia-regiao-serrana-2011/tragedia-na-regiao-serranateve- mais-mortos-que-divulgado-5685873.html. Accessed 22 Jul 2016

DeWalt KM, DeWalt BR (2002) Participant observation: a guide for fieldworkers. AltaMira Press, Walnut Creek, CA

Dubois O (1998) Capacity to manage role changes in forestry. Introducing the 4R's framework. In iied. Forest Participation Series; 1. ISSN 10266887

Dyer J, Stringer LC, Dougill AJ et al (2014) Assessing participatory practices in community-based natural resource management: experiences in community engagement from southern Africa. J Environ Manag 2014:137–145

Eden C (1992) On the nature of cognitive maps. J Manag Stud 29(3):261–265. https://doi.org/10.1111/j.1467-6486.1992.tb00664.x

Evers M (2012) Participation in flood risk management. An introduction and recommendations for implementation. Karlstad: Centrum för klimat och säkerhet, Karlstads universitet (Rapport/Centrum för klimat och säkerhet, 2012:1)

Fekete A (2012) Safety and security target levels. Opportunities and challenges for risk management and risk communication. Int J Disaster Risk Reduct 2:67–76. https://doi.org/10.1016/j.ijdrr.2012.09.001

Folhes RT, Dutra de Aguiar AP, Stoll E et al (2015) Multi-scale participatory scenario methods and territorial planning in the Brazilian Amazon. Futures 73:86–99. https://doi.org/10.1016/j.futures.2015.08.005

Fontana A, Frey J (1994) Interviewing the art of science, Pp. 361-76 in The Handbook of Qualitative Research, edited by N. a. Y. L. Denzin. Thousand Oaks: Sage Publications.

Fung A (2006) Varieties of participation in complex governance. Public Adm Rev 66(s1):66–75.https://doi.org/10.1111/j.1540-6210.2006.00667.x

Goldin I (2014) The butterfly defect. How globalization creates systemic risks, and what to do about it. Edited by Mike Mariathasan. Princeton University Press, Princeton
Grimble R (1998) Stakeholder Methodologies in natural resource management. Socioeconomic Methodologies. Best Practice Guidelines. Chatham, UK:Natural Resources Institute
Guha-Sapir D, Below R, Hoyois Ph (2015) EM-DAT: The CRED/OFDA International Disaster Database. Université Catholique de Louvain. Brussels – Belgium. http://www.emdat.be/database. Accessed 28 Sept 2016
Hassenforder E, Ducrot R, Ferrand N et al (2016) Four challenges in selecting and implementing methods to monitor and evaluate participatory processes: example from the Rwenzori region, Uganda. J Environ Manag 180:504–516. https://doi.org/10.1016/j.jenvman.2016.05.019
Horita FE, Albuquerque JP (2013) An approach to support decision-making in disaster management based on Volunteer Geographic Information (VGI) and Spatial Decision Support Systems (SDSS). Supporting disaster management using VGI and SDSS
IRGC (2010) An introduction to the IRGC Risk Governance Framework, from the 1 IRGC White Paper No1 "Risk Governance – Towards an Integrative Approach", IRGC, Geneva, 2005.
Kangas A, Laukkanen S, Kangas J (2006) Social choice theory and its applications in sustainable forest management – a review. Forest Policy Econ 9(1):77–92. https://doi.org/10.1016/j. forpol.2005.02.004
Kapucu N, Garayev V (2011) Collaborative decision-making in emergency and disaster management. Int J Public Administration 34(6):366–375. https://doi.org/10.1080/01900692.2011.561477
da Mata Siqueira AM (2015) Conflitos em contextos de desastres relacionados com as águas. In Riscos de desastres relacionados à água
ISDR (2005) Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters. Extract from the final report of the World Conference on Disaster Reduction. http://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf. Accessed 14 May 2016
Mauelshagen C, Smith M, Schiller F et al (2014) Effective risk governance for environmental policy making; a knowledge management perspective. Environ Sci Pol 41:23–32. https://doi.org/10.1016/j.envsci.2014.04.014
McGurk B, Sinclair J, Diduck A (2006) An assessment of stakeholder advisory committees in forest management: case studies from Manitoba, Canada, Society & Natural Resources An International Journal, Volume 19, 2006 - Issue 9 pp 809–826
Munich Re (2016) Worst natural disasters statistics | Munich Re. https://www.munichre.com/en/reinsurance/business/non-life/natcatservice/significant-natural-catastrophes/index.html.Accessed 28 Sept 2016
Neuman WL (2006) Social research methods: Qualitative and quantitative approaches PMNF (2016) Plano diretor da prefeitura municipal de Nova Friburgo. Nova Friburgo RJ. https://www.meioambientedigital.pmnf.rj.gov.br. Accessed 17 Jan 2017
Renn O, Walker KD (2008) Global risk governance. Concept and practice using the IRGC framework. Dordrecht, the Netherlands: Springer (Book series on global risk governance, 1)
Royal Society Study Group on Risk Assessment (1992) Risk: analysis, perception and management/ report of a Royal Society Study Group. The Royal Society, London
Schensul JJ (2013) Focused Group Interviews. Enhanced Ethnographic Methods Smith W, Dowell J (2000) A case study of co-ordinative decision-making in disaster management.Ergonomics 43(8):1153–1166
Steelman TA, Maguire LA (1999) Understanding participant perspectives. Q-methodology in national forest management. J Pol Anal Manage 18(3):361–388. https://doi.org/10.1002/(SICI)1520-6688(199922)18:3<361::AID-PAM3>3.0.CO;2-K
Stern PC, Fineberg HV (1996) Understanding risk. Informing decisions in a democratic society. National Academy Press, Washington, DC
Taylor-Powell E (1998) Program development and evaluation: questionnaire design: asking questions with a purpose
Ulrich H, Probst G (1995) Anleitung zum ganzheitlichen Denken und Handeln. Ein Brevier für Führungskräfte. 3., erw. Aufl. Edited by Gilbert J. B. Probst. Bern: Haupt
Usón TJ, Klonner C, Höfle B (2016) Using participatory geographic approaches for urban flood risk in Santiago de Chile. Insights from a governance analysis. Environ Sci Policy 66:62–72. https://doi.org/10.1016/j.envsci.2016.08.002
Vacik H, Kurttila M, Hujala T et al (2014) Evaluating collaborative planning methods supporting programme-based planning in natural resource management. J Environ Manag 144:304–315. https://doi.org/10.1016/j.jenvman.2014.05.029
Walonick DS (2003) Survival statistics. StatPac, Minneapolis WFD (2010) The EU Water Framework Directive information sheet. With assistance of European Commission
World Bank (2012) Avaliação de perdas e danos. Inundações e Deslizamentos na Região Serrana do Rio de Janeiro – Janeiro de 2011. http://mi.gov.br/pt/c/document_library/get_file?uuid=74dde46c-544a-4bc4-a6e1-852d4c09be06&groupId=10157. Accessed 09 Nov 2015

FOURTH CHAPTER (JOURNAL PUBLICATION)

4 What influences disaster risk perception?[3]

Intervention measures, flood and landslide risk perception of the population living in flood risk areas in Rio de Janeiro state, Brazil.

Alicia Bustillos Ardaya, Mariele Evers, Lars Ribbe

Abstract

The flooding and landslides catastrophe in 2011 in the mountainous area of Rio de Janeiro State in Brazil affected more than 300,000 people and created unquantifiable material losses, mostly in the Nova Friburgo Municipality. Even with the available technologies, programs and measures for disaster prevention, the population was not prepared. Following international frameworks like the Hyogo, governmental institutions related to risk management started working with the population to improve response, preparedness and perception. This work aims to evaluate disaster risk perception (DRP) and intervention measures of the population living in flood risk areas and relate it to variables such as landslide risk perception, experienced disasters and intervention measures taken from institutions and the population. Through 391 quantitative questionnaires and 20 semi-structured qualitative interviews, we reveal the connection between DRP, the people who may be affected and the strategies for response and preparedness of the institutions. Using descriptive statistics, factor analysis and regression, we develop six main factors related to risk perception. The regression defines flood risk perception (FRP) as the dependent factor and exposes the small influence on FRP from state and municipal institutions working with disaster risk reduction (~ 0.01) in comparison to past experiences (~ 0.52), demographic characteristics (~ 0.29) and local influences (~ 0.62). Supporting literature about DRP, examples about institutional influences are given. Hard and soft intervention measures exemplify neighborhoods developing perceptions according to institutional influences, local organization strategies and marginalization level, highlighting the importance of local participation on risk reduction programs to improve perception, trust and therefore, intervention measures.

Keywords: Flood risk perception · Institutional influence · Local management · Disaster risk reduction · Hard and soft intervention measures

[3] Elsevier | International Journal of Disaster Risk Reduction
25 (2017) 227-237 DOI: http://dx.doi.org/10.1016/j.ijdrr.2017.09.006
Available online 14 September 2017

4.1 Introduction

The frequency of extreme water related risk events worldwide is increasing, as is the number of people affected and the damage caused by such events events (Guha-Sapir et al., 2015; Munich Re, 2016), Floods and landslides impinge upon human security and therefore affect sustainable development (Adikari and Yoshitani, 2009; Guha-Sapir et al., 2015). Absolute prevention or absolute protection against floods through management is unachievable, and something which goes beyond management is needed (Scott et al., 2013). Risk appraisal and perception modifies risk management decisions and, therefore, management actions (IRGC, 2010a) making it a crucial aspect. Several researchers (Slovic, 1987; Sjöberg, 1999; Paton, 2001; Slovic and Weber, 2002; Sjöberg et al., 2004; Burns, 2007; Lindell and Hwang, 2008) have defined disaster risk perception (DRP) as the motivator of priority settings, preventive activities and resources allocation (Becker et al., 2014). Recent research on flood risk perception (FRP) highlighted the importance of knowing the causes for determined protective actions, intervention measures (IM), trust in public and private protective measures, and perception on risk management responsibilities (Birkholz et al., 2014). Rainfall-runoff monitoring and flood forecasting modeling processes are essential technical processes for disaster risk management. Adding social dimensions as understanding, knowledge exchange and local perception, increases the effectiveness in management (Birkholz et al., 2014). Some difficulties of social dimensions, such as local perception, are that they are dynamic according to specific location, situation and influences (Rowe and Wright, 2001; Slovic, 1987). Defining and understanding variables and factors determining DRP and the influence of IM in specific areas might provide public and private institutions with a valuable vision to better develop disaster risk management strategies. Considering landslides, droughts, IM and other variables in the specific area of Nova Friburgo, we take flood risk perception (FRP) as a main and dependent factor for DRP because of the history of occurrence on the area and the intervention of public institutions (Section 4.1.1).

This paper aims to analyze and determine the factors related to DRP taking FRP as the dependent factor and the population living in the flood risk areas of Nova Friburgo Municipality in Brazil as the specific case. Through factor analysis and correlations of quantitative questionnaires complemented with qualitative semi-structured interviews, the following research questions are addressed: 1) What are the most influential factors that affect FRP in the area? 2) What is the influence of public institutions on DRP in comparison to civil societies initiatives? 3) How do these factors interrelate with and influence specific DRP?

As part of the introduction, Section 4.1.1 explains the Rio de Janeiro (RJ) and Nova Friburgo (NF) risk management and warning system. Section 4.1.2 provides the definitions of FRP and IM used for this paper. The methodology for the selection of the population, questionnaires type, data collection and statistical processing is described in the second section. The third section (4.3) presents the resulting correlation of FRP to the variables measured and the interaction of the factors with IM taken in the area, discussing their relation to public institutions and civil society. Specifically, Section 3.1 describes and analyzes the correlation of the variables with FRP. The questionnaires contain four principal indicators for protective mitigation behavior, divided into soft and hard measures according to the definition of the United Nations Office for Disaster Risk Reduction UNSDR (UNISDR, 2015b). The willingness and the capacity to move out of a risk area, contention measures and reforestation are among the hard intervention measures (HIM) detailed in Section 4.3.2. Among the soft intervention

measures (SIM), we consider knowledge about risk maps, preparedness courses, knowledge about sirens and evacuation points, communication on safety actions and existing SMS groups for risk alarms. All SIM are detailed in section 4.3.3. In addition, Section 4.3.4 further discusses the influence of public institutions working on disaster risk reduction and local influence is analyzed and compared between the selected areas before the conclusions in section 4.4.

4.1.1 Flood risk, landslide risk and warning system in RJ

Rio de Janeiro is the first industrial state in the country, demonstrating considerable economic growth after the economic recovery of the last 20 years. This significantly changed migration patterns in the whole state. Producing more than 82% of the national oil production, and with a GDP per capita of 26,250 R$ (±8402 US$) (IBGE, 2017), there was an evident increase in the dynamism of the social, economic and environmental spheres. Consequently, the urban expansion and informal settlements have also increased during recent years. Nova Friburgo was one of the most affected municipalities, together with Teresópolis and Petrópolis. It has a population density of approx. 200 hab./km^2 (IBGE, 2010) and is the fourth most populated municipality in the State.

Flash floods, floods and landslides have long affected the state of Rio de Janeiro, especially on the west to east mountain chain that reaches more than 2000 m.a.s.l. The orographic barrier blocks the oceanic currents coming from the south provoking heavy rainfalls on the mountainous region. The years 1986, 1997, 2005 and 2007 were some in which severe rains caused several floods with severe consequences (Ferreira, 2016). The frequency and magnitude of these phenomena are both due to the climatic, geomorphologic and geologic characteristics of the area (e.g. tropical climate, weathered soils and extensive mountainous areas) and to the presence of areas characterized by high population density and unplanned and spontaneous land occupation (Coelho-Netto et al., 2007). Nevertheless, the flash floods and landslides of January 2011 were the worst disaster in Brazil in terms of human losses and people losing their houses and livelihoods to the floods and landslides, resulting in more than 900 deaths and 300,000 affected people, as confirmed by official data (World Bank, 2012). However, following calculations based on around 8844 electricity meters lost (887 in Nova Friburgo) and registrations in the electric power company (Energisa) that were never rehired, it has been suggested that actual losses were 8–10 times greater (Canejo, 2015; Custódio and Corrêa, 2012).

On the night of 10 January 2011, the national meteorology institute INMET registered 166 mm of rain for Nova Friburgo city, which is 70% of the monthly average for January. The soil was saturated because of a rainy month, so the water level rose in a couple of hours. A representative of the Geological survey service (DRM), affirms that the strong thunders during the rain were triggers of the landslides and the thin soil layer above the rock, characteristic of the mountainous areas, contributed to the hundreds of landslides. Roads, communication, energy, water and sanitation facilities were destroyed leaving some regions isolated, as one dweller in Nova Friburgo confirmed: “on the third day after the tragedy I still couldn’t know if my family on the other side of the city was alive”. Public infrastructure was lost and productive sectors were also affected, the World Bank estimated a total of R$ 2.2 billion ($1.3 billion) costs in direct damages. Houses and buildings located in or close to steep hills and close to the rivers were destroyed leaving around 39,000 people homeless or displaced, most of them were informal housing (favelas). As one of the dwellers described about Sao Jose neighborhood: “the entire neighborhood was under debris, unrecognizable”.

The National Center for Natural Disaster Monitoring and Alert (CEMADEN) at national level and the Secretariat of Civil Defense (SEDEC) in Rio de Janeiro State are responsible for articulating technical information received by the federal and local governments related to possible climatic events. This information is mostly provided by the State Institute for the Environment (INEA) and the Geological Survey Service of State (DRM), according to the new institutional rearrangement (GITEC / IP/ CODEX REMOTE, 2013), created to define specific processes and products of the institutions working on disaster risk reduction in the State (Reed et al., 2009). After the 2011 floods and landslides, local and international institutions focused on infrastructural and non-infrastructural projects in the most affected areas. After reconstruction projects, led mostly by the state or municipal government with federal resources, institutions related to risk management, environment and land use had to increase research and improve their work with the local population. Federal funds were released to increase the response and preparedness through awareness and training programs.

The INEA created the Center for Information and Environmental Emergencies (CIEM). This monitoring and warning system is a simple model. Water level information from telemetric monitoring stations is sent in real-time to INEA webpages, and a warning level (red, yellow or green) is displayed according to stream overflow level calculations previously made for every station. This information is also sent by SMS to the registered population when thresholds are surpassed. DRM risk maps are based on digital elevation model maps and historical information about previous landslides and developed in GIS by local technicians. Civil Defense (CD) and the municipal prefecture work directly with people who may be affected. They offer preparedness courses free of charge, survival kits, evacuation simulations with the installed sirens, information and have developed a SMS alert system together with INEA. International institutions like Care International and the Red Cross, national institutions like INCID, IBASE and organized neighborhood associations and active citizens' groups also undertake different activities with the population living in risk areas in order to improve their knowledge and protection, as well as preparedness.

4.1.2 Disaster risk perception framework

The definition of DRP is based on several approaches. From a rationalist approach, an evaluation of benefits versus cost (gains and losses), to a constructivist approach, which defines risk perception as a dynamic practice imposed and shaped by societies, showing that many elements must be taken into consideration. In essence, we define risk perception as a predecessor of mitigation behavior or IM, as is classified by Bubeck et al. (2012) and Birkholz et al. (2014) specifically for floods. Mitigation behavior, defined by the UNISDR as practicing the limitation of adverse impacts of hazards and related disasters, is generally divided into hard intervention measures HIM (e.g. infrastructure, technology) and soft intervention measures SIM (e.g. policy, instructional, communication) (IPCCC, 2011; Lopez et al., 2011). Among the constructivist approaches, the protection motivation theory presents four factors that define a preservation behavior: perceived severity of a threat, perceived probability of occurrence, perceived usefulness or effectiveness of any recommended response and perceived ability to implement response response (Birkholz et al., 2014). Bubeck et al. (2012), classifies the first two as threat appraisal and the third and fourth as coping appraisal.

DRP defines IM, but also intervention measures taken, will influence on DRP. It is important to consider that in addition to the four factors previously mentioned there are many external factors that can change perception. The IM strategies used by the people who may be affected depend mainly

on three things: improving knowledge of causes and likelihood of flooding, social memory of past events and reduction of reliance on public structural measures measures (Birkholz et al., 2014). The first two measures are basically dependent on SIM (e.g. communication to increase knowledge and experience of the surrounding areas, policies for risk alarms). Only the third is a perception of structural measures like contention walls. Among the factors considered, FRP is strongly affected by socio-economic and demographic characteristics (Lin et al., 2008; Pelling, 1997) and previous experiences (Burn, 1999). Johnson et al. (2004) and Tierney (1999) also defended the premise that social construction of risk is dynamic and often imposed by power structures and unequally experienced by marginalized groups. In this sense, we separate public power from civil society influences on DRP of each of the dwellers in the neighborhoods studied.

In order to have an idea of the causes of FRP, a regression is used to evaluate different variables. Threat appraisal (severity and probability of occurrence) is measured and taken as a dependent factor while coping appraisal, experiences of past events and demographic factors are measured and taken as independent factors. In this document, the critical analysis is focused on the role of governmental institutions and organizations versus the influence of the local population by shaping flood risk perception in the context of a major disaster that took place in 2011 in Rio de Janeiro.

4.2 Methodology

The data collection was principally based on questionnaires designed under Taylor-Powell (1998) and Walonick (2003) methodologies. Questionnaires were held in Portuguese answered by the population living in flood risk areas in a door-to-door survey. These were complemented by semi-structured interviews of the personnel working in the main institutions related to disaster risk reduction in the state (Fig. 4.1), following Fontana and Frey (1994) and Ulrich and Probst (1995) methodologies. Most of the data was taken between August 2015 and January 2016. Some expert interviews were held in September 2014 to design the fourth part of the questionnaires, and the first questionnaires were conducted in March 2015 for testing and revision. The selected sub-basin, Rio Dois Rios, has an area of 4.375 km2 and a population of 371,255 inhabitants; it is composed totally or partially of 12 municipalities, all of them in Rio de Janeiro State. Nova Friburgo (985 m.a.s.l.) is the head of the basin, was heavily affected in 2011, and thus it was selected as a focus municipality. Bom Jardim, Trajano de Morais Sao sebastiao de alto and Sao Fidelis were selected for comparison and validation purposes, as part of the Rio dois Rios basin (Fig. 4.2).

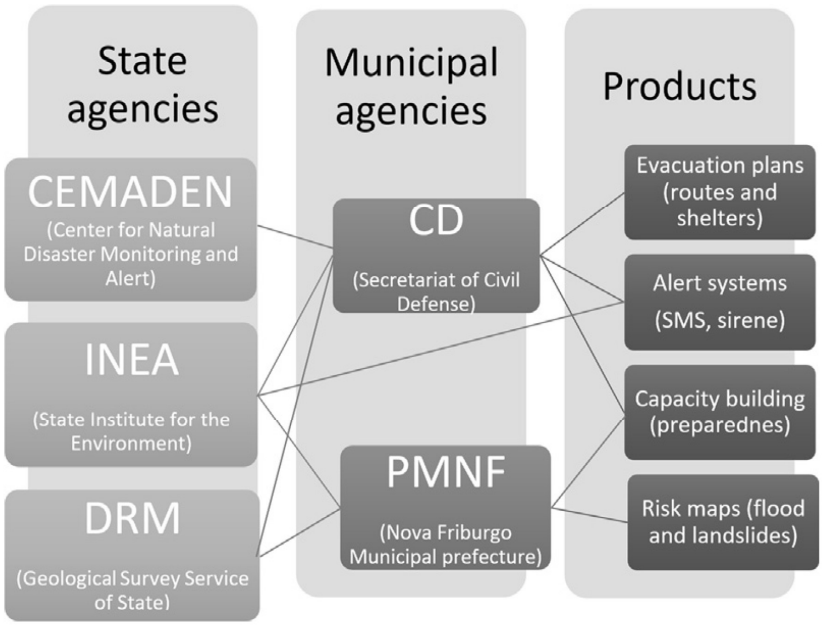


Figure 4.1 Institutions working in the studied area.

Households in rural (n = 115) and peri-urban (n = 276) risk areas were selected for the questionnaires. An official delimitation of the risk areas (both in rural and in urban areas) was given by INEA, based on a flood model created with the HEC HMS and HEC GIS programs by Ecologus, a consultant outsourced after the 2011 tragedy. Based mainly on the DEM and a 15–30-m buffer zone around the rivers, official flood risk maps were developed, locating red (high flood risk in the buffer zone) and yellow (mid-flood risk near the buffer zone) zones and highlighting the houses located in both risk areas for Campo de Coelho (CC), Corrego Dantes (CD), and Rio Grandina (RG). These maps were made to plan a green protected area around the river in the most affected areas in the municipality of Friburgo, and also to relocate the population living in these risk areas.

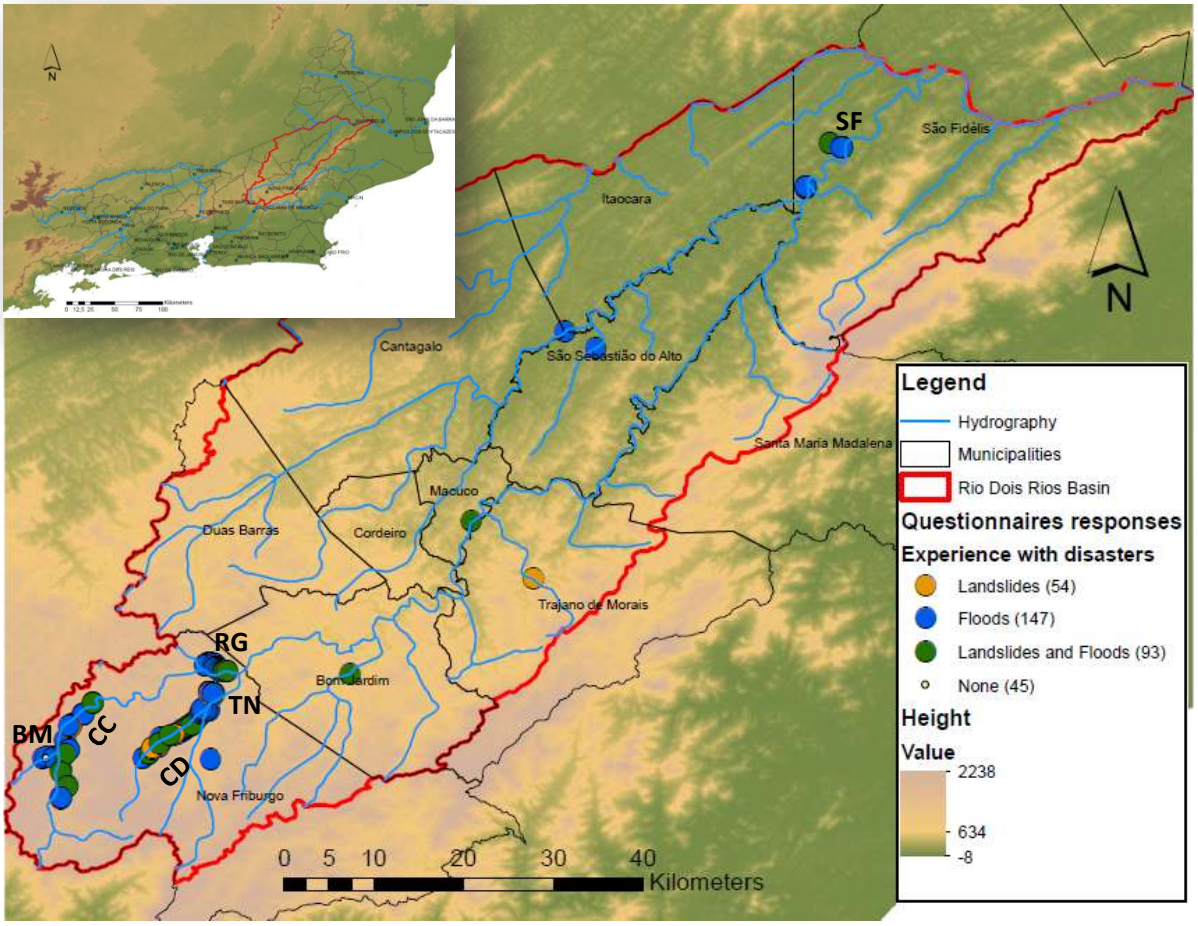


Figure 4.2 Survey location according to disaster experience

Out of around 385 houses officially marked as under severe risk on INEA risk maps, 160 were demolished or abandoned, from the 225 houses standing in the risk areas, 217 (56%) responded to the questionnaires. The abandonment was driven by fear of a new event or under a contract with INEA where they received a house in the "Minha casa minha vida" federal program or received state or federal assistance to cover the monthly payment for a rented house. For the nonofficial risk areas in Sao Fidelis (SF), Barracao dos Mendes (BM), and Terra Nova (TN) the methodology was repeated, and houses were marked, following the DEM maps, methodology and buffer zone described by INEA. Representing rural areas in Sao Fidelis (SF), Barracao dos Mendes (BM) and peri-urban areas in Terra Nova (TN), the population living near the river participated in the same questionnaire. With the results, a contrast of the perceptions between rural and peri-urban areas, as well as official and non-official sites was evident. Table 4.1 shows the reported areas' division between rural - urban, unofficial - official INEA risk areas and some basic demographic data.

The questionnaire had four main parts: 1) General demographic data; 2) Previous experiences with natural disasters and adopted mitigation measures; 3) Perception of risk (severity and likelihood), and 4) Coping appraisal. Previous experiences with natural disasters and adopted mitigation measures (point 2), reflected mainly personal experiences during and after the tragedy of 2011 and previous disaster events; response measures taken during and mitigation measures taken after. This second

point helped the interviewee to become familiar with the subject; many of them gave confident details and specifications about their experience.

Table 4.1 General data of the interviewed population

	Rural areas		Peri-urban areas				Total
			Official INEA risk areas				
Location of the neighborhoods	SF Sao fidelis	BM Barracao d. Mendes	CC Campo do Coelho	CD Corrego Dantes	RG Rio Grandina	TN Terra Nova	
Number of questionnaires	21	49	45	124	48	104	391
Gender (female percentage)	71.43	42.86	40.00	45.97	62.50	32.69	44.76
Average (av.) Age in years	49.86	38.82	28.98	47.05	54.65	34.09	41.57
Av. Years living in the area (%)	24.38	18.84	11.82	27.08	34.92	6.18	19.55
Access to media (0-4 items: radio, tv, phone, internet)	3.33	2.71	1.84	3.25	3.13	2.12	2.71
Av. Pop. With formal work (%)	57.14	87.76	68.89	65.32	50.00	38.46	59.08
Av. Pop. Retired (%)	9.52	6.12	15.56	14.52	27.08	11.54	15.09
Av. Pop. Unemployed (%)	33.33	6.12	15.56	20.16	22.92	50.00	25.83
Av. Affected by inundations (%)	95.24	79.59	57.50	83.06	72.92	34.62	65.47
Av. Affected by landslides (%)	2.80	36.73	31.11	89.19	14.40	82.59	28.39

Perception of risk (point 3) evaluated their knowledge and the perception they have about their risk state; the likelihood of a future event where they live (flood or landslide) evaluated in a scale from 1 to 4 and how severely they could be affected evaluated qualitatively. Flood risk perception of the residence (from no risk at all to high risk) is the independent variable for the correlation (Table 4.2).

Coping appraisal (point 4) evaluated response efficacy and self-efficacy; the influence of the state and municipal institutions in their preparedness (e.g. infrastructural vs. non-infrastructural measures) and measures taken by them for preparedness, possible long/short-term measures financial or physical help received from institutions, family and/or neighbors. Using affirmations previously made by institution experts, we could ask the population about their knowledge about specific programs and projects aiming to educate the population and increase preparedness. This point also evaluates people's perception of their environment, knowledge about rainy – dry season, natural surroundings and the importance of reforestation activities and ecosystem services.

The factor analysis in SPSS divided the 42 variables (26 main + 16 secondary) into six main factors: general demographic information (e.g. years living in the area, gender, age, working sector, telephone, internet access), geographical location (e.g. distance to the urban center, distance to the river, street locations, schools, hospitals), previous experience with risk events (e.g. experienced floods, experienced landslides, evacuation and contention measures), knowledge of ecosystem-based disaster risk reduction measures (Eco-DRR, reforestation effects, green areas' importance, infrastructure value, local surroundings), local influence (e.g. information and help received from

family and friends, knowledge by own and family and friends' experience) and institutional influence (e.g. knowledge of the INEA system alert, knowledge of existing risk maps, participation of CD capacity building).

Table 4.2 Parts, factors and variables of the quantitative questionnaires

Questionnaire	Main Factors	Main Variables	Secondary variables
Part 1. General demographic data	1. General demographic information	Years living in the area, gender, age, telephone and internet access	Working sector, TV and radio possession, priority subject in the area,
	2. Geographical location	Geographical location (distance to the urban center, river, street, schools and hospitals)	Altitude
Part 2. Previous experiences with natural disasters and adopted mitigation measures	3. Previous experience with risk events	Quantity of previous experienced floods, quantity of previous experienced landslides, evacuation process taken, contention measures taken, appraisal of preparedness level	Date and severity of last events, intention of relocation, economic capacity of relocation
Part 3. Perception of risk	**Flood Risk Perception (independent variable)**, landslide risk perception,		
Part 4. Coping appraisal	4. Knowledge of ecosystem-based disaster risk reduction measures	Eco-DRR knowledge, reforestation effects, green areas' importance, infrastructure value, local surroundings	Knowledge on rainy seasons, knowledge on risk areas nearby
	5. Local influence	Information about possible risk events from family and friends, help received from family and friends, knowledge from experience, knowledge family and friends' experience,	Precautionary actions from family and friends, satisfaction with received help
	6. Institutional influence	Information about possible risk events, from institutions, help received from institutions, information from the INEA system alert, knowledge about existing risk maps, participation in CD capacity building,	Precautionary actions from institutions, satisfaction with received help, knowledge of web pages of alert, response to alert signals, appraised utility of alert signals

For the data analysis of the quantitative data of the questionnaires, categorical responses were coded into numerical scales with four options (from not at all to very much) plus an open-ended option. Open ended questions were qualitatively analyzed and recoded into new categories. After simple descriptive statistics, a factor analysis (based on an original correlation matrix of the variables involved) was conducted in SPSS. A simple linear regression (Ordinary Least Square with link, beta and robust test) was run with Stata for the analysis of all variables. The regression analysis considered flood risk perception as the dependent factor and the 26 main variables as independent factors. After a link, beta and a robust test, and some graphical methods for inspecting data including Cook's D, the quantity of observations was reduced to 302, excluding all cases in Sao Fidelis and other municipalities, which were at the end of the basin and had different flooding conditions (< 0.02).

The 20 semi-structured interviews conducted by the author lasted from one to two hours and were addressed to experts working in institutions and living in the risk areas, selected by snowball sampling method. At least one dweller of each area working in a committee or mentioned by the surveyed people and at least two representatives of all institutions described in Section 4.1.1 (Fig. 4.1) were selected, including technicians working in specific risk programs (like CIEM in INEA). In the case of institution experts, subjects were related to the functioning and organization of the institution, their relation to other institutions and their relation to the people who may be affected. Data about alert systems, preparation and preparedness programs was analyzed and separated into categories comparable from institution to institution. These categories were used for the formulation of the

fourth part of the questionnaire related to institutions influence. Due to the limitations of this paper, discourse analysis was left aside for future analysis. All qualitative data taken was recorded and the aspects related to the six factors was used to qualitatively justify, reinforce or question the quantitative results. Furthermore, a simple count on intervention measures suggested by the experts opened the comparison between hard and soft intervention measures in Sections 4.3.2 and 4.3.3.

4.3 Results and discussion

This section first places the flood risk in context with other types of disasters occurring in the area. After a description of the main variables affecting FRP, an analysis of the factors they represent highlights the influence of the different stakeholders. In order to describe the specific measures taken, an analysis of specific hard and soft IM is presented. The discussion concludes with clarification of the role of civil society in the study case.

4.3.1 Perception of potential victims

The questionnaires focused principally on floods and landslides. Droughts came up as a subject of discussion in some cases and were later considered for the discussion. Although the river level has considerably decreased in the last three years, drought is not perceived as a problem in these areas. Considering that the population interviewed lived near rivers, the lower water levels were first associated with flood risk reduction more than water scarcity, especially in the peri-urban areas. During the qualitative interviews, experts affirmed that they are not working on droughts since "it is not part of their specific responsibilities or objectives".

The perception of the population about floods was much more concrete than their perception of landslides due to heavy rainfall. In total, 15.56% considered that they were living in a landslide area considered to be dangerous to very dangerous, while 37.50% considered they were living in a flood area considered to be dangerous to very dangerous (Table 4.3). This perception was common in mountainous areas due to key physical processes that enable easier early recognition of types of floods (Manandhar et al., 2015). Also, floods are historically more frequent than landslides in this particular area. Added to this, the perception of a possibility of new landslides in the interviewed areas was relatively low, many of those interviewed argued that the catastrophe of 2011 was a once in a lifetime event, or as a dweller in CD said: "all that had to slide did already slide". With all these arguments, we used flood risk perception as a central point and dependent variable in the subsequent analysis.

Table 4.3 Description of experience and perception of floods and landslides (N=391)

	Population that experienced…	**Perception of house in a very dangerous or dangerous location for…**
Floods	68,28%	37,50%
Landslides	42,19%	15,56%

After extraction of the cases of Sao Fidelis, as explained in the methodology, the result of the simple linear regression in Stata is statistically significant, Prob>F is equal to 0.00. Since this is an explorative analysis the result of R-square is limited to 0.3393, meaning that only 34% of the FRP may be explained by the studied variables. Fig. 4.3 shows the main variables and their relation to FRP. The strongest

correlation in the figure is with the experience of floods (coef. = 0.52), which is not surprising. Experience increases perceived probability of a further risk. The experience of landslides on the other hand, is negatively related to flood risk perception with a negative coefficient (coef. = −0.32). Those who experienced landslides perceived that there was less of a flood risk that may cause damage to their housing. This may be explained by the destruction caused by landslides compared to floods in 2011. In both cases, the result is clearly significant and relevant. The significant influence of previous experiences in risk perception and protective decisions is already mentioned in previous research (Kellens et al., 2013; Morss et al., 2015; Siegrist and Gutscher, 2006; Wagner, 2007).

Table 4.4 Linear regression, independent variables coefficient plus confidence interval (FRP as dependent variable)

Source	SS	df	MS	Number of obs	= 302
Model	126.41	30	4.21	F (30, 271)	= 4.64
Residual	246.17	271	0.90	Prob >F	= 0.0000
Total	372.58	301	1.23	R- squared	= 0.3393
				Adj R-squared	= 0.2661
				Root MSE	= 0.9531

Flood Risk Perception (DV)	Coef.	Std. Err.	t	P>|t|	95% Conf. Interval	
Distance to the urban center	0.0001	0.01	0.82	0.410	-.0001	.0001
Distance to rivers	-0.0075	0.08	-0.09	0.932	-.1811	.1661
Years living in the area	0.0152	0.01	3.90	0.000	.0075	.0229
Gender (fem)	0.2956	0.11	2.49	0.014	.0614	.5298
Experienced Floods	0.5284	0.21	2.51	0.013	.1142	.9425
Experienced landslides	-0.3217	0.15	-2.08	0.038	-.6256	-.0179
Informed by experience	-0.4669	0.41	-1.13	0.259	-1.2797	.3458
Informed by local population	-0.6229	0.43	-1.43	0.154	-1.4818	.2360
Registered for info. services	0.0170	0.10	0.16	0.876	-.1966	.2307
Knowledge of INEA system	-0.0075	0.13	-0.06	0.954	-0.2655	.2504
Part of a CD capacitation	-0.0570	0.19	-0.29	0.775	-.4487	.3347
Reforestation as best measure	0.1073	0.13	0.77	0.442	-.1668	.3814
Green areas importance	-0.0737	0.08	-0.84	0.403	-.2468	.0994
_cons						

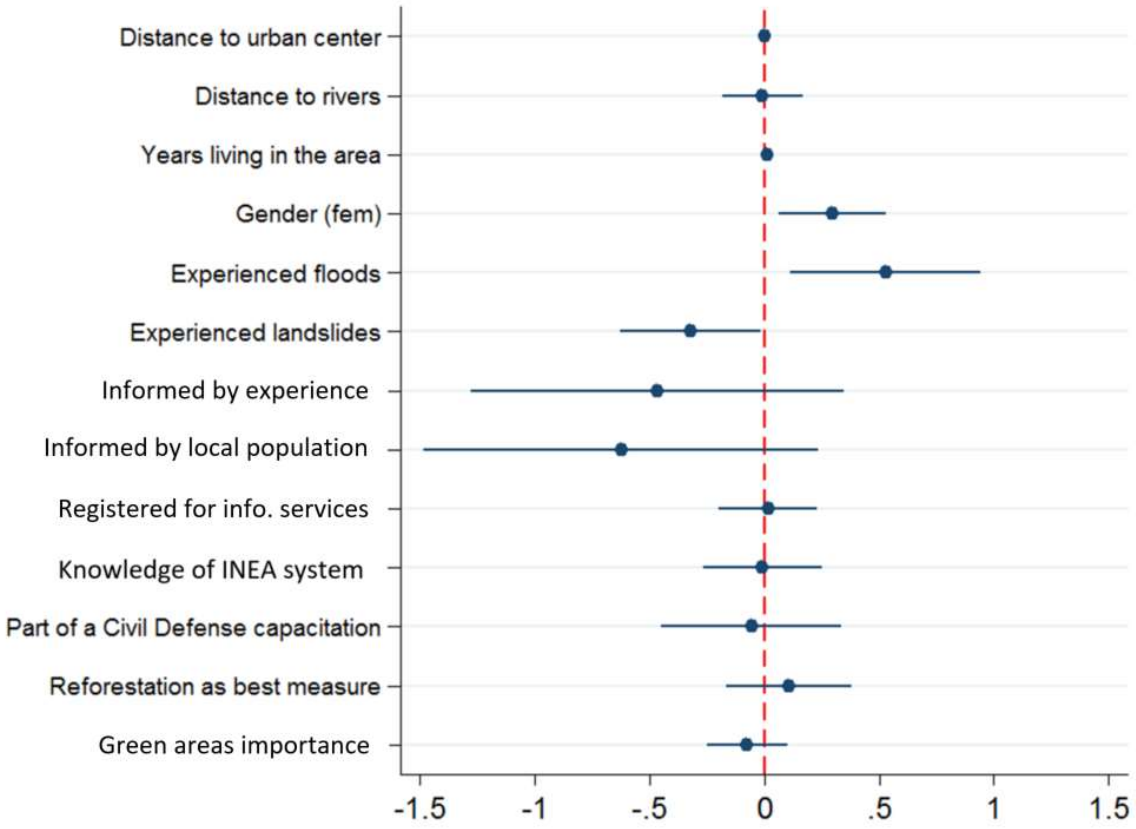


Figure 4.3 Linear regression, independent variables coefficient plus confidence interval (flood risk perception as dependent variable). n = 302, R2 = 0.34, Prob>F = 0.00

Demographic variables such as gender (coef. = 0.29), age, years living in the area, communication facilities and income had more significance than location variables like closeness to urban centers (coef. = 0.01), rivers, roads and other facilities. The significance of gender variables is greater in countries where both legal and cultural differences between genders are stronger, like the case presented in Pakistan (GGCA, 2013). In the case of Brazil, without being extreme, gender plays an important role for FRP. Aspects of the possession of communication services such as telephone (coef. = 0.39) or internet (coef. = −0.30), are the most significant results. Age and years living in the area have a valid P>|t| value (under 0.1 and 0.05 respectively) but their coefficient is weaker (coef. = −0.01 and 0.01 respectively). In this context, people living longer in the area have more experience with past flood events and a slightly higher FRP (knowledge of historical floods effects, location of vulnerable places and vegetation around the area). On the other hand, age, having a negative coefficient, has an inverse relation to FRP. More research would be needed to explain this result. In the case of location variables, considering that all interviews were conducted with households close to rivers in neighboring areas, certain homogeneity is given in the sample. This homogeneity prevents geographical differentiation and more significance in the results. Also, there was a low relation of flood perception with factors of eco-DRR measures perception, such as the importance of green areas for risk prevention (coef. = -0.07) and the role of reforestation in the surroundings (coef. = 0.10).

The variables of being part of the Civil Defense routine (P>|t| = 0.775; coef. = −0.05) or being linked to public information services (P>|t| = 0.876; coef. = −0.01) do not seem to have a significant correlation to FRP. Local influence and information coming from neighbors, family and friends (P>|t| = 0.154; coef. = −0.62) have, in this case, more relevance than institutional influence. During the interviews, many were able to give better examples of effective prevention measures taken by neighbors and families, than public institution recommendations. Risk perception was mainly based on a comparison with the neighbors. In RG a dweller argued: “it doesn’t matter if institutions give us a map showing that this is a risk area, as long as other people are also living here, it can’t be that dangerous”.

Among the reasons for this difference, there are arguments that there is mistrust in the government in terms of how data is created, the intentions behind the information given and the lack of presence of the institutions in specific areas and at a constant rate. In other words, legitimization, as Tierney (1999) argues. This is a crucial point, because from all the measured variables, influence from public institutions and influence from neighbors, friends and family are variables that are easier to create, work on and change. While it is difficult to create or change risk experiences, it is possible to create spaces for IM exchange or improve public power influences.

4.3.2 Perception of hard intervention measures

Out of all the individual hard IM, the most extreme to be taken by population living in risk areas is to move to a safer area. Relocation as an adaptation solution creates many controversies (King et al., 2014) such as socio-spatial incompatibilities (Eranıl Demirli et al., 2015) and the search for optimal programs for relocation (Prasetio et al., 2012). In this case, relocation is not an easy task considering that more than 70% of the Municipality of Nova Friburgo is under severe risk (SMMADUS, 2016). Even with the knowledge that they are living in a risk area, moving out is not a priority for the population; 43% of the total surveyed population thinks there is a necessity to move out, but only 23.8% are in some way in the process of moving out. Nevertheless, leaving the actual house after considering that it is under risk is only a solution for those who can afford it; 15.6% did not have the economic resources or the opportunity to move out. Only 5.8% had developed some kind of contention measure in order to improve their home's safety (Fig.4.4).

The population located in official risk areas had to be relocated to the well-known “minha casa minha vida” federal relocation program. Working in 23 states, the program aims to enable house and apartment ownership to low income families. Although criticized for manipulating urban planning in order to liberate sub-used urban areas, by 2016 more than 4.6 million houses had been built. In the case of Nova Friburgo, the project “Terra Nova” was located close to Conselheiro Paulino, one of the largest neighborhoods north of the city. This comprised several buildings of seven blocks with 6–9 floors, each with between 2 and 4 flats with two rooms each. There were 2.337 benefited families planned for 2014, and until 2015, around 1.400 families were able to live in the flats (Globo, 2014). From the 104 surveys in TN, 72 were households moved from risk areas in the last 2 years. More than half (52.7%) of the 72 surveyed people that had already moved to TN were very satisfied with the help received. Nevertheless, during deeper investigation in the qualitative interviews, many problems were exposed. The developers are several years behind with the construction of services such as nurseries, schools and hospitals or clinics for the number of people residing there. Space was limited for average families requiring flats with more than two rooms. The population came from rural areas,

most of them farmers, who had lost their livelihoods and were unable to produce anything in the small space received. Some people manifested their dissatisfaction in violence and dangerous gangs formed. These topics are in the agenda of local non-governmental institutions like INCID (2015) and Viva Rio (2016) and require further analysis. With this information, people still living in risk areas prefer to ensure their home is safe before accepting a move to resettlement neighborhoods, drastically changing their risk perception.

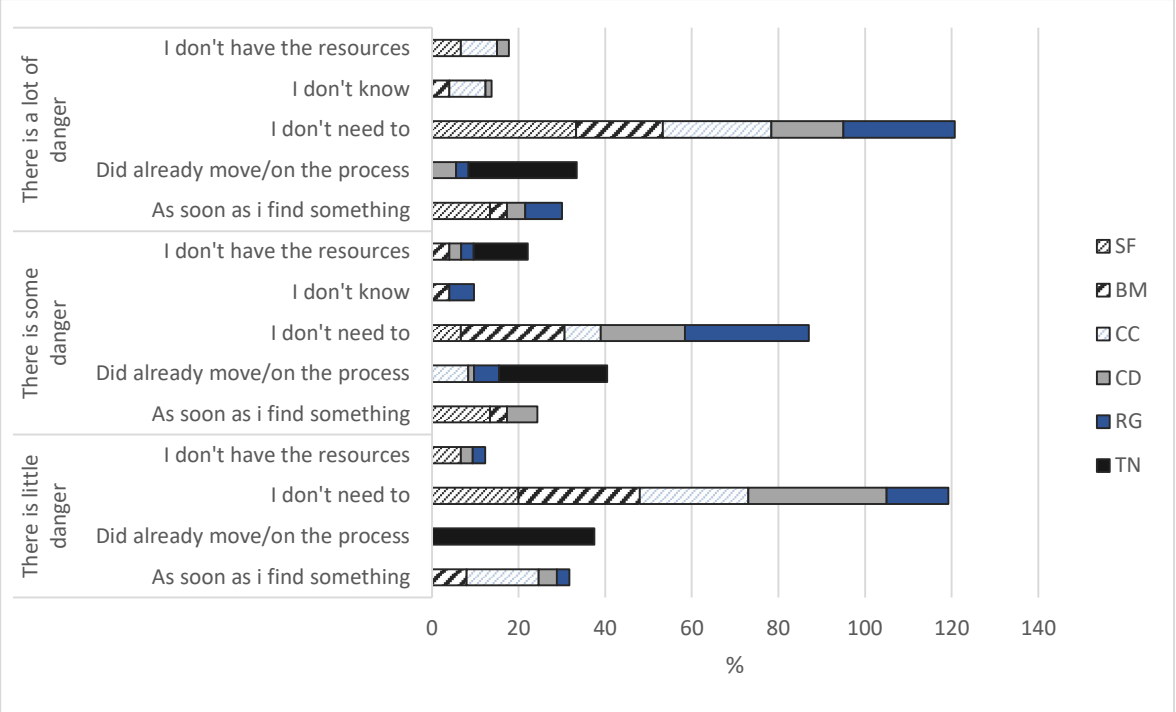


Figure 4.4 Relocation intentions and possibilities of people perceiving some kind of danger (n=167)

Perception of HIM is still highly rated as the best solution to reduce risk and is to be analyzed in both ways. Governments will prefer to invest in visible constructions and infrastructure to show progress. Local dwellers at the same time expect these types actions from the government; during interviews, phrases as “there is a channel being constructed along the river to reduce risk”, or “the government should build more contention walls in order to reduce risk” were very common. In general, visible infrastructure counts as tangible projects for the government, because as a dweller argumented “they have a specific action, goal and construction time”. Some 35.7% of the population, mostly in the peri-urban areas, put contention walls above reforestation and education for risk reduction (Fig. 4.5). People placing responsibility on institutions to take charge of risk reduction is to the detriment of the importance of actions of self-protection (Bodoque et al., 2016).

The advantages of ecosystem-based adaptation measures (EbA) are increasingly becoming more evident, economically and functionally, in rural and also peri-urban areas (Brink et al., 2016; Daigneault et al., 2016). Reforestation in the surrounding areas is either very important or relatively important for 91.8% of the population. Nevertheless 64.3% had never undertaken any kind of recovery or conservation action in or near their properties, and from the 35.7% who has done so, only 7.21% still do. A replantation or reforestation possibility is mostly limited to those living in the rural

areas, since they could easily access some space on their property, garden or near the house. Also, actively planting trees privately is not a frequent practice, since by just avoiding "cleaning" an area (by cleaning, is referred to the action of cutting bushes and plants out), they perceived an automatic increase of bushes and threes. When giving three possible infrastructural solutions (dams, river channeling, and contention walls for landslides) and three non-infrastructural solutions (reforestation, education of risk areas and conservation of green areas) to risk reduction, reforestation and conservation was the best (or one of the best) measures perceived by only 31.6% of the population (Fig. 4.5). When ecological measures are mentioned, cleaning river banks is often suggested as a measure. Nevertheless, cleaning in this context refers to the extraction of trees, bushes and grass on the surroundings of the river rather than improving water quality.

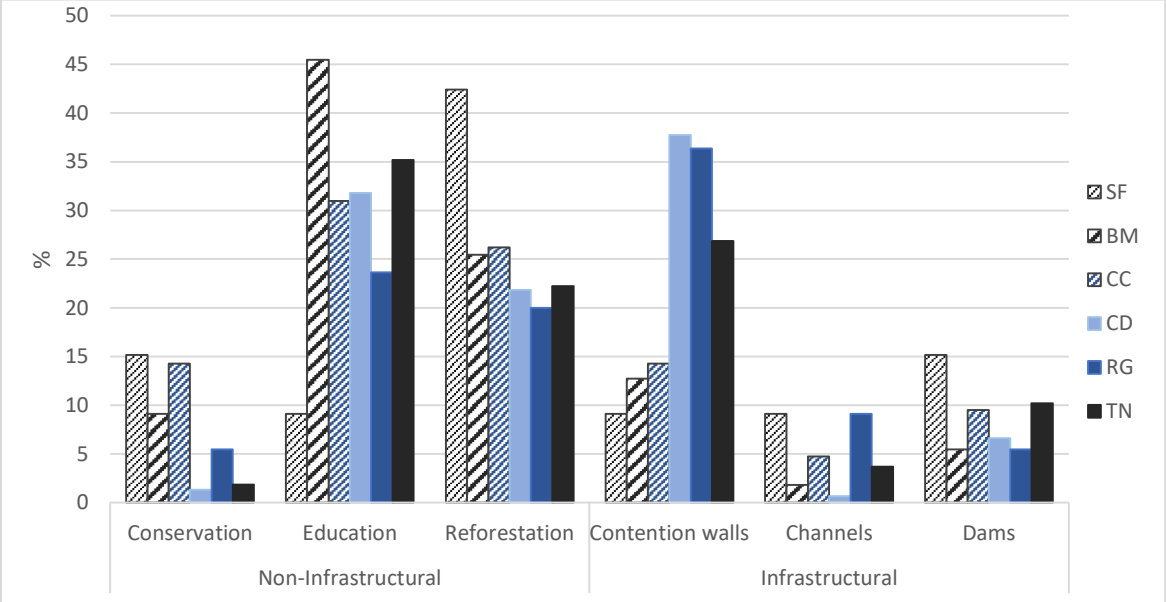


Figure 4.5 Percentage of population per area perceiving a priority for DRR (n=343)

4.3.3 Perception of soft intervention measures

Capacity building for risk warnings responses and knowledge on preparedness measures may define response efficacy. We have taken institutional strategies as variables to be measured as factors influencing people's perception. With regard to the production of institutional rearrangement (GITEC / IP/ CODEX REMOTE, 2013), many dialogs and meetings had to be carried out in order to understand and agree on the internal functioning of the institutions. Along with this process, it was clear that despite the existence of relative clarity inside every institution, integration between the different institutions working on disaster risk reduction was needed. From the qualitative interviews held in 2015, it was also clear that the processes were not fully discussed with all agencies concerned and that capacity building was needed in order to fully understand technical information and further possible processes. Intra- and inter-institutional communication problems were cited three times as a missing point among the ten stakeholders working in the different institutions who were interviewed.

Although the Civil Defense reaches more population in Nova Friburgo than in any other municipality after RJ, the actual knowledge of the population about current strategies, instruments and

contingency plans is limited. As presented in Table 4.3, the role of institutions in flood perception has to be improved in terms of trust, communication channels and language in order to reach a greater number of the population. The strategies developed are low in impact in the population interviewed, nevertheless there are many emerging alternatives being developed by NGOs and the organized population (Table 4.4).

Although most of the population has some kind of communication media at home (TV, radio, internet and/or telephone), most of the risk information is given by neighbors, family or direct observation. Although 81.89% of the interviewed population has access to cellphones, less than 25% of the population is registered with any kind of SMS information service. Some of those registered claim that messages are no longer sent and that information received is not exact or useful for their specific location. The online alert system of INEA depends on the internet, accessible for 42.43% of the population; 38.11% of the interviewed population knows something about the early warning system of INEA available online, nevertheless only 9.73% have accessed the web page at least once.

The communication channels are continuously diversifying: even though the institutions use sirens, SMS and web sites, the population always finds new channels and better ways to communicate or reach the community. Independent from the institutions, different groups in social media (such as WhatsApp and Facebook groups) are being created by local initiatives. These groups are constantly actualized by the population in different areas of the region, warning about the current situation in different neighborhoods, integrating and disseminating news of Civil Defense, the Red Cross, the firemen, INEA and the Climatologic Center amongst others. There are more than 17,300 members in a Facebook group for precipitation and flood alert just for Nova Friburgo, and diverse groups in WhatsApp according to specific regions. Although these methods reach more of the population due to their diversity and the associations by city and families, they are informal, prone to panic, unspecific in information quality and length, and disorganized. There are many opportunities for reaching the population and implementing new tools to solve problems like excess or false information, disorganization and panic creation.

The INEA risk maps were known only in the neighborhoods that had to be evacuated, since the relocation process was based on those maps. For instance, in Córrego Dantes, the population who refused to move out had a good knowledge of the risk maps. In some cases, they could highlight mistakes in the limitation of the risk areas based on their own experience. The methodology for the official risk maps was very difficult to track down. For the neighborhood Association in Córrego Dantes, it took more than a year to find a proper explanation of the methodology used for the risk maps.

Table 4.4 Institutional recognition, perception and local complementary strategies

Institution	Strategy	Population (%)	Alternative Population Initiatives
INEA	Subscribed to INEA SMS alert system	4.05% (15)	Several social groups have been created (e.g. WhatsApp) for risk alert in specific areas (e.g. CD, RG, for the city center). In these groups, information about the current situation in specific places is combined with official data.
	Knowledge of alert system website	38.11% (141)	Social media groups created by the organized population (e.g. Facebook group for risk and alert in NF) with direct access, warnings and comments about the official meteorological websites (INMET, INEA and CD).
	At least one visit to the website	9.73% (36)	

DRM	Knowledge of the flood risk maps	15.95% (59) + possible 8.38% (31)	A community-based risk mapping was organized in 2012 by some NGOs in the most affected areas. Skills on mapping methodologies and the use of GPS were part of the project.
	Knowledge of landslide risk maps	3.78% (14) + possible 8.38% (31)	The maps of DRM are created for the municipalities, focused on future planning. No direct access to the population.
Civil Defense	Subscribed to DC SMS alert system	18.11% (67)	Although this is the same system as INEA (first row), most of the population refers to the SMS system as the one from DC.
	Participation in capacity building courses	11.35% (42)	Courses and simulations have less attendance than expected, adding to the capacity building of the population, there are Red Cross groups doing risk reduction and first aid courses all year.
	Perception of sirens (very - little useful)	79.45% (290)	Many arguments against sirens because of false alarms and fear triggers, and the process following the alarms is not clear. Most of the surveyed people reacted to neighbors and family notifications and alerts in the lasts risk event
	Reaction to sirens (Frequently, always)	44.93% (164)	

The Civil Defense offers courses with evacuation routines and information in case of the activation of sirens in the city center of Nova Friburgo and in some other main neighborhoods. This course is given free, in public places and periodically to those who are interested, but among those interviewed, only 11.35% had taken it. The use of the sirens is considered to range from 'a lot' to 'some' use by 79.45% of the population, but 55.06% confessed that they never react to it, some argue: "we know that we have to go out when the alarm is issued, but we don't know where to". This fact supports Kellen's Kellens (Morss et al., 2015) theory that the term warning is not as important as the information content. Added to it, after many false alarms or failure to communicate simulations, trust has been diminished. A dweller in CC affirmed that "refuges installed by civil defense are extremely small for the population they intend to shelter and some of them are even located in unsafe places". This may be the reason why more than half (54.32%) of the interviewed population would prefer to evacuate to family or friends' houses located farther away from the river.

4.3.4 Influence of civil society on perception

After INEA declared Córrego Dantes as one of the most affected neighborhoods, a river park and a preserved area was proposed in this neighborhood. All families living in the risk area are to be relocated to Terra Nova and their houses demolished for the park. As soon as the proposal became official, local groups started to organize, gather information about regulations, information sources and the methodologies used for the risk maps. More than four years later, they created links and agreements with the Faculty of Geography of the UFRJ (Rio de Janeiro Federal University), investigation teams with Embrapa and ONGs working on risk like Viva Rio and Fiocruz. Nowadays, they have a strong information network, leading integrated research in the area, and have constructed a communal center with funds from the Swiss government. This is an example of organization and communication at local level. The perception of the local population in this area was clearly bigger in terms of local map knowledge, participation in courses, knowledge of the local surroundings and communication networks.

Many of the people interviewed discard the probability of another catastrophe like 2011 on the basis that the drought is ongoing. The current drought affecting the entire state is now a federal concern. In the rural areas, producers declared that they have been trying to dig water wells deeper and four of them declared that they had even lost springs in their territories. The farmers in CC meet once a month to discuss the situation, obtain information and search for alternatives and processes to reach solutions. During the meeting one ensured that "there is a state program now, bringing technologies to get access to quality groundwater".

Responses related to non-protective measures were also considered. In particular, these included fatalism, wishful thinking and hopelessness related to religion. In Brazil, only 8% of the population consider themselves to be not religious and 89% are either catholic, evangelic or spiritualist (IBGE, 2013). Answers such as, “whatever God's will is, it will happen” in CD or “whenever He wants to take me, it is because it is my time” in RG or “it is not possible to know the intentions of the Lord” in BM were mentioned when people were asked about their private precautionary measures. A limitation on the analysis on religion is given since this was not a variable in the questionnaires. The numbers attending churches and ritual centers increased in NF due to the trauma caused after 2011, and “the need of support after the loss of beloved ones” as a dweller in TN explained. The awareness of their inability to control events as Rotter (1966) explains, plays a significant role that can be further analyzed. Surviving the incident of 2011 meant for many of them that nothing worse could happen, if they and their houses survived the worse event in the history of the place, then they could survive anything.

Considering these examples, the interest and participation of the community is essential in order to continuously seek information and be aware of the changing environment. Even when risk reductions programs can play an important role in affecting risk perception (Sullivan-Wiley, 2017), the importance of considering civil societies influence is evident. Constant innovation and dynamism in the implementation of private mitigation measures is driven by the population. There is a great deal of potential for the institutions, who could add some of these capacities into their programs.

4.4 Conclusions

In this paper explored the most influential variables for FRP and the interrelation of factors influencing DRP. From the six factors analyzed, flood risk perception is principally influenced by past experiences and demographic factors, followed by civil society and the influence of public institutions, respectively. This work focused on the analysis of civil society and public institutions’ influence since those are factors that can be worked on, changed and therefore improved. According to the questionnaires taken, most of the population takes no part in the programs, courses or information networks offered by public institutions. Despite limitations on deeper analysis on discourse and social networks we relate this fact to communication methodologies, mistrust and skepticism, as the participation of institutions working in risk reduction has diminished in recent years. In the area studied, civil society's influence is clearly stronger; reasons such as communication channels, language and credibility were analyzed with specific examples.

Trust among dwellers is stronger in neighborhoods where representatives or population organizations are continuously working and exchanging information. Although power is clearly dictated by specific people in charge, associations are strongly linked to research projects, universities and even political parties. We evaluated the determinant variables defining perceptions of specific hard and soft intervention measures taken by the population and the influence of public institutions. HIM are generally perceived as the best solutions for disaster risk reduction among civil society and public institution members due to visibility and clear starting and ending points. SIM related to communication on response and evacuations require more work to reach more of the population. Alternatives to specific soft IM being further developed by civil society initiatives were described and analyzed.

Climatic processes and consequences are dynamic and require constant adaptation of institutions and society. Technologies, tendencies and even changes in events, such as the gradual drought in the state, require constant renewal of approaches, both in the measures and perceptions of all stakeholders. The interest and participation of the civil society is essential in order to cope with dynamism; create and expand information and simultaneously educate and build awareness of the ongoing local problems. Since the influence of the organized population is greater than the influence of the institutions in this case, there is a great potential for institutions to work with the organized elements of society and on issues such as social capital. Future research should focus on long term interactions and communication mechanisms between public institutions and civil society to improve perception and management. These mechanisms should be related not only to one specific risk, but should include various aspects of local interest. Including civil society and creating sufficient geographical and temporal spaces for information and experience exchange, could significantly improve communication, knowledge, perception and management of the stakeholders.

Chapter references

Adikari Y, Yoshitani J. Global Trends in Water-Related Disasters: an insight for policymakers: International Centre for Water Hazard and Risk Management ICHARM; 2009.

Becker G, Aerts JCJH, Huitema D. Influence of flood risk perception and other factors on risk-reducing behaviour: A survey of municipalities along the Rhine. J. Flood Risk Manage 2014;7(1):16–30. http://dx.doi.org/10.1111/jfr3.12025

Birkholz S, Muro M, Jeffrey P, Smith HM. Rethinking the relationship between flood risk perception and flood management. Science of The Total Environment 2014;478:12–20. http://dx.doi.org/10.1016/j.scitotenv.2014.01.061.

Bodoque JM, Amérigo M, Díez-Herrero A, García JA, Cortés B, Ballesteros-Cánovas JA et al. Improvement of resilience of urban areas by integrating social perception in flash-flood risk management. Journal of Hydrology 2016.), http://dx.doi.org/10.1016/j.jhydrol.2016.02.005

Brink E, Aalders T, Ádám D, Feller R, Henselek Y, Hoffmann A et al. Cascades of green: A review of ecosystem-based adaptation in urban areas. Global Environmental Change 2016;36:111–23. , http://dx.doi.org/10.1016/j.gloenvcha.2015.11.003

Bubeck P, Botzen WJW, Aerts, J. C. J. H. A Review of Risk Perceptions and Other Factors that Influence Flood Mitigation Behavior. Risk Analysis 2012;32(9):1481–95.

Burn DH. Perceptions of flood risk: A case study of the Red River Flood of 1997. Water Resour. Res. 1999;35(11):3451–8. http://dx.doi.org/10.1029/1999WR900215.

Canejo A. Nº de vítimas em tragédia no RJ pode ser 10 vezes maior, dizem entidades, 2015. http://g1.globo.com/rj/regiao-serrana/noticia/2015/08/entidades-apontam-subnotificacao-de-vitimas-da-tragedia-de-2011-na-serra.html (accessed July 22, 2016).

Coelho-Netto AL, Avelar AS, Fernandes MC, Lacerda WA. Landslide susceptibility in a mountainous geoecosystem, Tijuca Massif, Rio de Janeiro: The role of morphometric subdivision of the terrain. Geomorphology 2007;87(3):120–31.

Custódio A, Corrêa T. Tragédia na Região Serrana teve mais mortos que o divulgado. EXTRA, 2012. http://extra.globo.com/noticias/rio/tragedia-regiao-serrana-2011/tragedia-na-regiao-serrana-teve-mais-mortos-que-divulgado-5685873.html (accessed July 22, 2016).

Daigneault A, Brown P, Gawith D. Dredging versus hedging: Comparing hard infrastructure to ecosystem-based adaptation to flooding. Ecological Economics 2016;122:25–35. ://dx.doi.org/10.1016/j.ecolecon.2015.11.023

Eranıl Demirli M, Tuna Ultav Z, Demirtaş-Milz N. A socio-spatial analysis of urban transformation at a neighborhood scale: The case of the relocation of Kadifekale inhabitants to TOKİ Uzundere in İzmir. Cities 2015;48:140–59.

Ferreira LC. “Pior enchente” do Rio de Janeiro completa 50 anos, 2016. http://www.ebc.com.br/noticias/meio-ambiente/2015/12/pior-enchente-do-rio-de-janeiro-completa-50-anos (accessed September 28, 2016).

Fontana A., Frey J, Interviewing The Art of Science, 1994.

GGCA. Gender and disaster risk reduction: Gender ans Climate Change with the United Nation Development Program; 2013.

GITEC / IP/ CODEX REMOTE. Concepção do arranjo Institucional e operacional para a gestão de risco de desastres no estado do Rio de Janeiro; 2013.

Globo Serrana Estado anuncia mais 780 moradias para Nova Friburgo, RJ, até dezembro: Nesta quarta-feira (12), 280 apartamentos foram entregues no Terra Nova.No total, serão investidos R$ 318,4 milhões em moradias no município. ⟨http://g1.globo.com/rj/regiao-serrana/noticia/2014/11/estado-anuncia-mais-780-moradiaspara-nova-friburgo-rj-ate-dezembro.html⟩.

Guha-Sapir D, Below R, Hoyois P. EM-DAT: The CRED/OFDA International Disaster Database, 2015. http://www.emdat.be/database (accessed September 28, 2016).

IBGE. Banco de dados socioeconomicos, 2010.

IBGE. Atlas do censo demográfico 2010. Rio de Janeiro: IBGE; 2013.
IBGE. Estadistica dos estados, 2017. http://www.ibge.gov.br/estadosat/perfil.php?sigla=rj (accessed January 16, 2017).
INCID. Cadernos Municipais dos Indicadores de Cidadania Nova Friburgo; 2015.
INEA expert. Working of CIEM and INEA system. Rio de Janeiro, 2015.
IPCCC. Water and climate change impacts and adaptation strategies: Technical paper; 2011.
IRGC. An_introduction_to_the_IRGC_Risk_Governance_Framework; 2010.
Johnson JG, Wilke A, Weber EU. Beyond a trait view of risk taking: A domain-specific scale measuring risk perceptions, expected benefits, and perceived-risk attitudes in German-speaking populations. Polish Psychological Bulletin 2004;35(3):153–63.
Kellens W, Terpstra T, Maeyer P de. Perception and Communication of Flood Risks: A Systematic Review of Empirical Research. Risk Analysis 2013;33(1):24–49. , http://dx.doi.org/10.1111/j.1539-6924.2012.01844.x.
King D, Bird D, Haynes K, Boon H, Cottrell A, Millar J et al. Voluntary relocation as an adaptation strategy to extreme weather events. International Journal of Disaster Risk Reduction 2014;8:83–90 http://dx.doi.org/10.1016/j.ijdrr.2014.02.006.
Lin S, Shaw D, Ho M-C. Why are flood and landslide victims less willing to take mitigation measures than the public? Nat Hazards 2008;44(2):305–14.
Lopez T de, Elliott M, Armstrong A, Lobuglio J, Bartram J. Technologies for climate change adaptation. The water sector; 2011.
Manandhar S, Pratoomchai W, Ono K, Kazama S, Komori D. Local people's perceptions of climate change and related hazards in mountainous areas of northern Thailand. International Journal of Disaster Risk Reduction 2015;11:47–59
Mercado R.M., People's risk perceptions and responses to climate change and natural disasters in BASECO compound, Manila, Philippines, Procedia Environ. Sci. 34 (2016) 490–505, http://dx.doi.org/10.1016/j.proenv.2016.04.043
Morss RE, Mulder KJ, Lazo JK, Demuth JL. How do people perceive, understand, and anticipate responding to flash flood risks and warnings?: Results from a public survey in Boulder, Colorado, USA. Journal of Hydrology 2015.
Munich Re. Worst natural disasters statistics | Munich Re, 2016. https://www.munichre.com/en/reinsurance/business/non-life/natcatservice/significant-natural-catastrophes/index.html (accessed September 28, 2016).
Pelling M. What determines vulnerability to floods; a case study in Georgetown, Guyana. Environment and Urbanization 1997;9(1):203–26.
Prasetio EA, Arifianti Y, Hardjakaprabon B, Agustin F. Triple Helix in Disaster Management: Case Study of Strategic Environmental Assessment (SEA) for Government Office Relocation Planning of Padang City, Indonesia. Procedia - Social and Behavioral Sciences 2012;52:150–9. , http://dx.doi.org/10.1016/j.sbspro.2012.09.451
Reed M.S., Graves A., Dandy N., et al., Who's in and why? A typology of stakeholder analysis methods for natural resource management, J. Environ. Manag. 90 (5) (2009) 1933–1949, http://dx.doi.org/10.1016/j.jenvman.2009.01.001.
Rotter J.B., Generalized expectancies for internal versus external control of reinforcement,Psychol. Monogr.: General. Appl. 80 (1) (1966) 1–28, http://dx.doi.org/10.1037/h0092976.
Rowe G, Wright G. Differences in Expert and Lay Judgments of Risk: Myth or Reality? Risk Analysis 2001;21(2):341–56. http://dx.doi.org/10.1111/0272-4332. 212116.
Scott M, White I, Kuhlicke C, Steinführer A, Sultana P, Thompson P et al. Living with flood risk/The more we know, the more we know we don't know: Reflections on a decade of planning, flood risk management and false precision/Searching for resilience or building social capacities for flood risks?/Participatory floodplain management: Lessons from Bangladesh/Planning and retrofitting for floods: Insights from Australia/Neighbourhood design considerations in flood risk management/Flood risk management – Challenges to the effective implementation of a paradigm shift. Planning Theory & Practice 2013;14(1):103–40.
Siegrist M, Gutscher H. Flooding risks: a comparison of lay people's perceptions and expert's assessments in Switzerland. Risk analysis an official publication of the Society for Risk Analysis 2006;26(4):971–9. http://dx.doi.org/10.1111/j.1539-6924.2006.00792.x
Slovic P. Perception of Risk. Science 236 1987:280285. ,
SMMADUS. Meio Ambiente Digital Nova Friburgo: Secretaria Municipal do Meio Ambiente e Desenvolvimento Urbano Sustentável, 2016. https://meioambientedigital.pmnf.rj.gov.br/ (accessed July 18, 2016).
Sullivan-Wiley K.A, A.G. Short Gianotti, Risk perception in a multi-hazard environment,World Dev. 97 (2017) 138–152, http://dx.doi.org/10.1016/j.worlddev. 2017.04.00
Taylor-Powell E., Program Development and Evaluation: Questionnaire Design:Asking Questions with a Purpose, 1998.
Tierney KJ. Towards a critical sociology of risk. Sociolical Forum 1999(14(2)):215–42.
UNISDR. Prepared for the 2015 Global Assessment Report on Disaster Risk Reduction: DIsaster risk reduction is an integral objective of environment related policies and plans, including for land use, natural resource management and adaptation to climate change; 2015.
Ulrich H., Probst G., Anleitung zum ganzheitlichen Denken und Handeln: Ein Brevier für Führungskräfte, 3., erw. Aufl. Haupt, Bern, 1995.
Viva Rio. Viva Rio lança projeto na Região Serrana, 2016. http://vivario.org.br/ (accessed July 18, 2016).
Wagner K. Mental models of flash floods and landslides. Risk analysis an official publication of the Society for Risk Analysis 2007;27(3):671–82. , http://dx.doi.org/10.1111/j.1539-6924.2007.00916.x.
Walonick D.S., Survival statistics. StatPac, Minneapolis, Minn, 2003.
World Bank. Avaliação de Perdas e Danos: Inundações e Deslizamentos na Região Serrana do Rio de Janeiro - Janeiro de 2011; 2012.

FIFTH CHAPTER (JOURNAL PUBLICATION)

5 Participatory approaches for risk governance?[4]

Exploring participatory mapping and mechanisms to close the communication gap between population living in flood risk areas and authorities in Nova Friburgo Municipality, RJ, Brazil.

A. Bustillos Ardaya, M. Evers, L. Ribbe

Abstract

Participatory approaches evaluating and changing risk appraisal and management are crucial aspects determining disaster risk governance. Due to the wide gap in governance structures in Brazil, the complexity of the institutional arrangements in the State of Rio de Janeiro, and the dynamics of the local and municipal context, more complete information on the existing participatory processes of local authorities and improvement possibilities is required. This study evaluated the influence of participatory mapping and other participatory approaches in the governance of institutions working in flood disaster risk reduction in one of the most affected areas during the 2011 flood and landslide disaster; the Nova Friburgo Municipality in Rio de Janeiro State. Semi-structured expert interviews in institutions related to disaster risk reduction revealed 12 institutions in the state implementing 36 participatory approaches or schemes at different levels (in term of authority and power, communication and decision mode, and participants). As a geographical approach encouraging participation, a method for participatory mapping was implemented, and the outcomes gathered were compared to one state and one municipal government participatory process outcome in the same region. Through the implemented participatory mapping, perceived risk areas, evacuation routes, and suggested shelters were identified and compared to official risk maps and information. The comparison between regional (mostly state) and local (mostly municipal) institutions showed the advantages of local institutions in the inclusion of the local population and better levels of communication. On the other hand, authority and power in policies and regional decisions was very low. This was confirmed in the specific case of the outcomes of the participatory flood risk maps; while spatial differences between the three compared maps were small, details on the evacuation points and routes adds value to maps co-created by the local population. The paper shows that the use of participatory mapping not only promotes participation, eases communication and social learning processes among stakeholders, but most importantly, it may create reliable, quantitative, and easy-to-use material useful for comparison and collaborative decision making. This understanding is crucial to identify and implement methods for participatory approaches at all levels that actually promote decision mode and helps institutions to improve work on disaster risk reduction.

Key words: Participatory risk mapping; Disaster risk governance; Risk perception; Disaster risk reduction

---

[4] Elsevier | Land Use Policy
88(2019)104103 Doi: https://doi.org/10.1016/j.landusepol.2019.104103
Accepted 15 July 2019

5.1 Introduction

5.1.1 Disaster risk governance and participatory approaches

Settlement patterns, changes in socioeconomic conditions, and urbanization are influencing rapid changes in social and natural environments (IPCC, 2012; Munich Re, 2016). An increase of risks is bounded to these changes as an emerging issue. There is a high level of confidence that disaster risk is not only growing in frequency as natural hazards increase, but also the number of affected people is increasing as vulnerability increases in developing countries (Pachauri and Mayer, 2015). Consequently, loss of lives, exposure, and material losses raise, and natural and social systems must change in structure and functioning, making the environment more dynamic. Disasters are also an expression of social issues, inequality, and rights reduction (da Mata and Antenora, 2015). Assessing these rapid changes in a globalized world requires adaptive governance, which implies a number of concerning challenges in its application to real-world cases (Sharma-Wallace et al., 2018), including the context where place-specific conditions and uncertainties of a fragmented system are taken into account (Pahl-Wostl et al., 2012:32). In the last decade, risk governance as defined by the IRGC has emerged as a focal point of policy attention in order to increase societal resilience (Alexander et al., 2016:38). The IRGC framework presents four interlinked elements: 1) Pre-assessment – Identification and framing, 2) Appraisal – Assessing perceived causes and consequences of risk, 3) Characterization and Evaluation – Making a judgment about the risk and management, and 4) Management – Deciding and implementing risk management. Additionally, three cross-cutting aspects connect all four elements: communicating, engaging with stakeholders, and considering the context. Appraisal and understanding, as crucial aspects of risk governance (IRGC, 2005), are influenced by existing participatory approaches (IRGC, 2010) and require connections between the population and institutions in both a top-down and a bottom-up approach (Usón et al., 2016:63; Renn, 2012). Participation in disaster risk management processes has great potential to create strong networks, increasing communication, knowledge (Van der Molen, 2018), and trust at all levels, and may enhance the response capacity of the population living in risk areas (APFM, 2006). As acknowledged by well-known agencies, such as the World Bank (World Bank, 2000) and the UNISDR (United Nations Office for Disaster Risk Reduction) (UN WATER, 2016; UNDRR, 2015), participation in disaster risk governance is complex in its application and has dynamic effects according the goals, population, location, area, and frequency that need to be analyzed for specific cases. The existing literature has presented many case studies, especially from European or North American countries, showing how to increase participation; like participatory citizen observatories (Wehn and Evers, 2015), monitoring and evaluation of rivers (Verbrugge et al., 2016), participatory modeling of river basins (Malve et al., 2016), and collaborative decisionmaking in flood risk management (Evers et al., 2016:343). Among the participatory approaches, participatory mapping (PM) is defined as a set of approaches that combine “tools of modern cartography with participatory methods to represent the spatial knowledge of local communities” (UNFCCC, 2016). Participatory mapping is a popular approach to determine the spatial distribution and support of decision-making to engage stakeholders (Brown et al., 2017). There are several examples of the use of PM related to disaster risk governance: disaster risk reduction using three-dimensional maps (Gaillard et al., 2013:160), generating landslide inventories (Samodra et al., 2018:306), spatial knowledge integration for flood risk reduction (Usón et al., 2016:70; Cheung et al., 2016:56) and some cases in Brazil (Andrade et al., 2017; Andrade and Szlafsztein, 2015). Participatory mapping provides many advantages for synthesis and integration and, nowadays, tools like

geographic information systems (GIS) and internet-based technologies increase the validity of results about a population's perceptions and improve the decision-making capacity of the citizens (Usón et al., 2016:70; Brown et al., 2017). Nevertheless, for regions where software and internet access are very limited, like rural and periurban areas in developing regions of South America, other approaches should be explored. One of the main issues about PM is understanding the influence of technology (as a practical application of mapping knowledge) on usability, user behavior and, most importantly, the influence on the outcomes to "provide evidence of success" (Brown and Kyttä, 2018).

5.1.2 Study área: Rio de Janeiro and Nova Friburgo

Brazil has a long history of disaster risk reduction (DRR) and related governance efforts. The first appearance was in 1824, when as an empire, article 179 of the constitution, guaranteed public aid to those affected by a disaster. In 1960, when after law 3.742 the country shifted from war-oriented protection (considering risk as e.g. war attacks), to natural disaster effects compensation (Universidade Federal de Santa Catarina, 2012; Defesa Civil, 2017). In 2012, law 12.608 was implemented, providing for the National System of Protection and Civil Defense (SINPDEC) and the National Council for Civil Protection and Defense (CONPDEC), authorizing the creation of Information Systems and Disaster Monitoring. On an international realm, in 2005 the Hyogo Framework for Action of the United Nations has been implemented in Brazil together with 167 other countries, aiming to increase resilience and implement DRR measures. However, this framework as national policy was only and partially adopted in most developed areas of the country (Bustillos Ardaya et al., 2015). The Sendai framework (2015–2030) is the successor instrument to the Hyogo, ensuring continuity with the work done previously, but has no official results to be analyzed.

As the first industrial State, with a GDP per capita of 8,13 US$ and more than 82% of the nation's oil production (IBGE, 2017), Rio de Janeiro has seen dynamic population and economic growth. Additionally, rapid urban expansion, informal unplanned settlements, the geologic, geomorphologic, and climatic characteristics of the area (e.g. weathered soils, the orographic barrier created by the 2000 m.a.s.l. mountain chain blocking the southern oceanic currents, and a tropical climate) have increased the frequency and magnitude of floods and landslides (Coelho-Netto et al., 2007). Since 1986, there have been several years when severe rains caused flash floods with fatal consequences (Ferreira, 2016). Nevertheless, the floods and landslides of January 2011 were the worst disasters in Brazil in terms of human losses and people affected. Official data reported more than 900 casualties and 300,000 affected people in Nova Friburgo, Petrópolis and Teresópolis (World Bank, 2012). On the other hand, calculations based on 8,844 electricity meters lost, and the number of not renewed contracts with the electric power company (Energisa), suggested that human loses were 8–10 times greater than officially reported (Canejo, 2015; Custódio and Corrêa, 2012).

On the night of 10 January 2011, the national meteorology institute (INMET) registered 166mm of rain in Nova Friburgo city, 70% of the historical average of the whole month of January. Due to constant rain during the previous month, the water level in the saturated soil rose in a couple of hours (da Mata and Antenora, 2015). Thunderous beating on the thin soil layer above the solid rock (a characteristic of this mountainous area) triggered hundreds of landslides (Nehren et al., 2019:20). Water, energy, roads, communication, and sanitation facilities were destroyed, affecting productive sectors and public infrastructure and creating 1.3 billion US$ costs in damages (World Bank, 2012).

Around 39,000 people were left homeless or displaced, few of whom had the potential to rebuild their houses and had to move to friends or neighbors (World Bank, 2012).

After all the initial efforts related to recovery from the incident of 2011, specific actions were taken by the authorities and institutions working in related areas to increase the response and preparedness among the population living in risk areas (GITEC / IP/ CODEX REMOTE, 2013). Various institutions initiated or strengthened programs that aimed to work with the population for capacity building, participation, information exchange, alarm systems, and evacuation processes (BBC, 2011). Participation of the municipalities and the local population was among the four main priorities of the process together with protective measures, technical structure, and the definition of the disaster areas and risks. Despite these programs, lack of trust in public institutions and NGOs among the population is evident. The perception of the population located in flood risk areas is much more likely to be influenced by neighbors and family compared to public institutions or NGOs (Bustillos Ardaya et al., 2017).

5.1.3 Participatory approaches

Several documents state the importance of participatory approaches in governmental institutions (Folhes et al., 2015; UNISDR, 2012). After the flood and landslide events, several questions emerged about the implementation of participatory mechanisms for disaster risk governance in the dynamic Brazilian context. The main objective of this paper is to assess the influence of the participatory geographic mechanisms (PM) implemented in the governance processes and structures; the quantitative differences in the results, the power and support of decision-making, and the qualitative changes or perpetuations of the mechanisms, including local knowledge and inclusion of participants in top-down and bottom-up approaches.

The authors first evaluated all participatory schemes of institutions working with the population living in or working with flood risk areas in Nova Friburgo, based on the participation categories presented in Fung's democracy cube (Fung, 2006a, 2006b). To further explore participatory approaches and their influence in disaster risk governance, the authors compared the performance and outcomes of risk mapping activities for disaster risk reduction (DRR) led by governmental institutions in the State of Rio de Janeiro, by Nova Friburgo Municipality, and added a bottom-up participatory mapping developed by the author to contrast the other two cases. The second part of this paper will further explain the methodology, the framework used to evaluate participation dimensions, and the modifications made to it (5.2.1). The interviews, the focus groups' (FG) structure and the methodology for participatory mapping are described in Section 5.2.2 and 5.2.3. The results in Section 5.3 will first describe the existing participatory approaches (5.3.1) and the classification of them in the three ranges of participation (5.3.2). Finally, geographical differences in the participatory approaches will be described through the flood risk maps (5.3.3). The main differences between state, municipal and regional approaches will be discussed (5.4) to highlight the main differences and conclusions (5.5).

5.2 Methodology

The field research for secondary data collection, interviews and focus groups was conducted between August 2014 and December 2017 in Nova Friburgo Municipality (11 months on the field). This was based mainly on semi-structured interviews, exploratory focus groups, and document revision. These

methodologies were used to evaluate the participatory approaches of the main institutions related to disaster risk reduction in the State, framed in Fung's three dimensions of participation (Section 5.2.1) and following Fontana and Frey's(Fontana and Frey, 1994) suggestion of triangulated methodologies and types of interviews according to role, setting, and purpose. The combination helped to gain a better understanding of the qualitative information and a deeper exploration of all the participatory schemes used in the area. First, all participatory approaches of institutions concerning population living in flood risk areas were surveyed through interviews. Additionally, for a deeper and interdisciplinary assessment of the results, processes for risk maps creation from a State and a Municipal institution were compared. Second, ten participatory risk maps (PM) created using Ares and Risler's methodologies (Ares and Risler, 2013) during eleven focus group (FG) interviews (Schensul, 2013) conducted by the first author of this paper were also compared to the two existing risk maps from the municipality and a state institution (Fig. 5.1).

The comparison is based on geospatial differences between the three risk mapping processes results, and analysis of the participation level, communication, and decisions made based on these products. The interviews and the focus groups were complemented with observations during workshops and meetings, and the analysis of secondary data, such as institutional arrangements, risk studies in the area, and project informs.

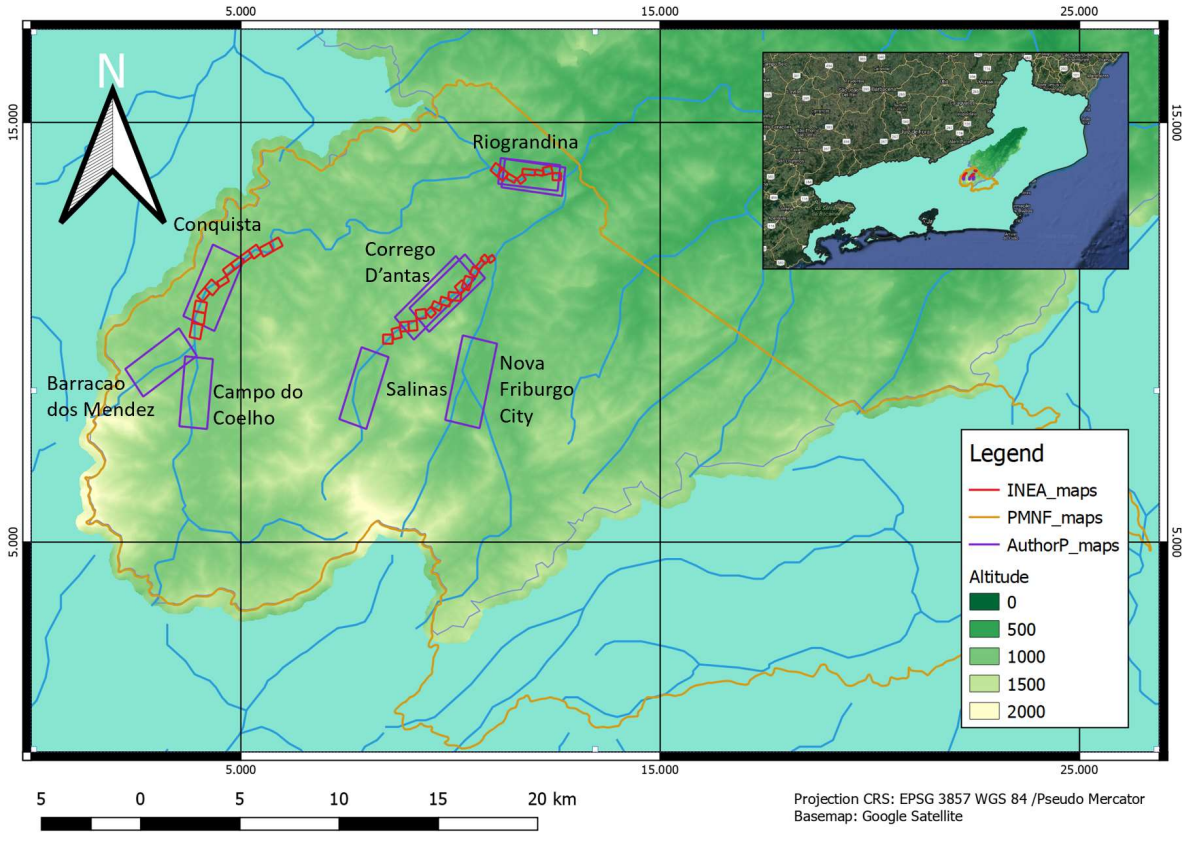


Figure 5.1: Areas of the 3 flood risk maps. INEA from the state, PMNF from the municipality and the PM by the author

5.2.1 Public participation

The international association for public participation (IAP2) works with a spectrum of participation increasing the impact on the decision that starts in informing and goes all the way to consulting, involving, collaborate, up to empower. The IAP2 spectrum is only focused on one dimension: decision mode. For this case, a spectrum for two other dimensions (participants and power) had to be included. For our purpose and in order to classify range of institutional possibilities for public participation and compare them, the three dimensions of the democracy cube (Fung, 2006b) were modified by adding some stages specific for a DRR case (Fig. 5.2): 1) participant selection, from very exclusive (experts and administrators) to very inclusive (citizens/public sphere), 2) communication and decisions, from not intense (listen as spectator) to very intense (technical and expertise), and 3) authority and power, from the least authority (individual education) to the most authority (direct authority) (Fung, 2006a). The advantage of this framework was that it also considered legitimacy, injustice, and effective governance and the adjusted levels were also used for social analysis in flood risk management cases (Wehn and Evers, 2015:190; Wehn et al., 2015).

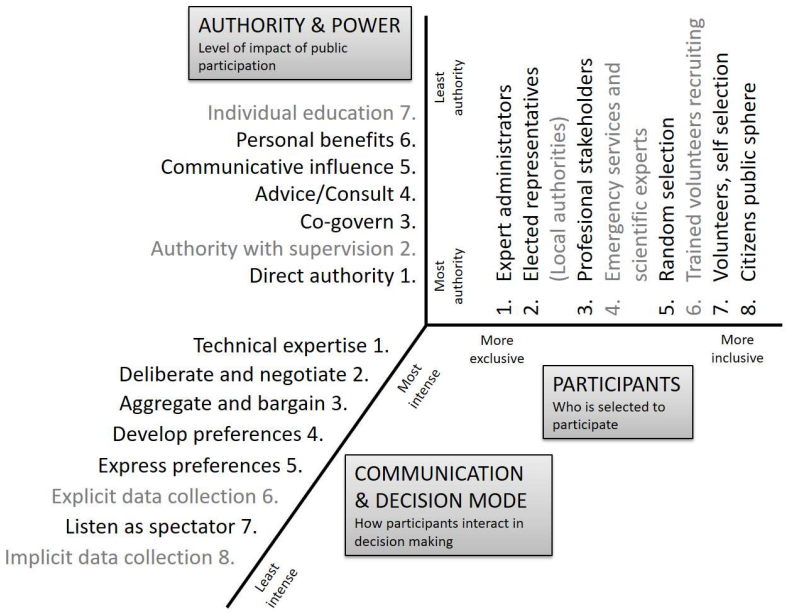


Figure 5.2 Varieties of participation in three aspects. Adjusted stages in lighter color (Fung 2006)

In the participants' sphere, an "emergency services and scientific experts" level was added to the original scale, since it is a specific case that is frequently given in DRR (Hassenforder et al., 2016:509). In the communication and decision mode sphere "implicit and explicit data collection" were added, as the DRR case has a lower level of participation than "listen as spectator" which was in the original version. To the level of authority and power, the levels "authority with supervision" and "individual education" were added. Additional to the analysis of the participatory processes, a comparison, and analysis of the outcomes enriched the discussion with quantitative data for an interdisciplinary approach.

This scale, with a verbal and written description, was shown during the interviews, so respondents could locate each participatory scheme/ program, in one level of these three scales according to their

perception. In the four cases of additional interviews per scheme/program an average was taken. The scales also induced a qualitative analysis of the constraints to reach higher levels in the scales and opportunities in other cases.

5.2.2 Interviews

For the semi-structured interviews, relevant organizations and offices for DRR were selected based on a previous study of the institutional arrangements (GITEC / IP/ CODEX REMOTE, 2013) and snowball sampling. With a duration between 40 and 70 min, the interviews were conducted in Portuguese, audio recorded, and notes were also taken. To evaluate how different organizations pursued participatory schemes, and how these schemes were perceived by the respondents, the main author asked the respondents three main questions. After a description of the main duties and objectives within their institution, they had to answer if and how the participation of other institutions, experts, or the population living in risk areas was pursued. Then, for every scheme described, an evaluation was performed following the criteria of Fung's triangle (Fig. 5.2) and a clarification was the main and central output. Finally, an examination of the connections with other institutions and networks was necessary to understand the processes and linkages between institutions and ended every interview with a snowball sampling technique. Based on the responses, 36 different participation schemes in 12 institutions were registered, and a framework comparing participation stages in the three dimensions was created (Table 5.1).

Table 5.1 Institutions, schemes, and respondents participating in the semi-structured interviews

Acronyms in Portuguese	Institution related to DRR	Listed participatory processes or schemes	Respondents
INEA	State Institute for the Environment	Early warning system, Flood risk maps, SMS system	4
DRM	State Geological Survey Service of State	Imminent risk maps, Contingency plans	2
CEMADEN RJ	Center for Natural Disaster Monitoring and Alert (state level)	Sirens systems, SMS warning system, Monitoring of the stations	1
CEMADEN Reg	Center for Natural Disaster Monitoring and Alert (regional level)	Local sirens, SMS warning system, Scholar community agent, Capacity building, Simulations	1
AGEVAP	Paraiba do Sul Water Basin Agency	Networking, Basin information management	2
GIDES	Integrated Management of Disaster Risk project from the Japan International Cooperation Agency - JICA	Risk maps, Mapping manual, Capacity building for institution workers	2
SEDEC	Secretariat of Civil Defense	Evacuation plans, Shelters	1
VR	INEA Regional Hearing Agency Viva Rio	Ouvidouria (ombudsman), Environmental education, Inclusive workshops	1
CD	Municipal Civil Defense	Simulations, Capacity building, NUDEC (support networks), Community monitoring	1
PMNF	Municipal Environmental Prefecture	Maps for urban planning, Public audience, Community meetings, Technical capacity building	4
RCNF	Red Cross Nova Friburgo	First aid course, Rescue course	1
REGER	Network for risk management in Corrego D'antas	Research sharing, Networking, General assistance	1
	Total institutions: 12	Total participatory processes/schemes: 36	Total respondents: 21

5.2.3 Flood risk maps

While four organizations worked with geographical information systems, only two institutions, INEA (state level) and PMNF (municipal level), had developed a process to map flood risk (flood risk maps FRM), both with urban planning intentions. The team developing INEA risk maps had to be different from the decision-makers by law, and therefore INEA hired Ecologus consulting group that developed the risk maps (scale 1:2750) after the 2011 catastrophe (INEA, 2011). Based on aerial photographs, digital elevation models, a 15-meter buffer zone around the rivers and a hydrologic modelling system (HEC HMS and HEC GIS) created by US Geological Service, the maps marked red (high flood risk) and yellow (middle flood risk) zones and highlighted the houses located in both risk areas. These risk maps were presented to the local population for education purposes and later used for relocation of the population living in risk areas. Out of around 385 houses officially marked red in Corrego D'antas, Riograndina, and Conquista neighborhoods, 160 were demolished or abandoned. The abandonment could be driven by fear of a new event, under a relocation contract with INEA ("Minha casa minha vida" federal housing project), or with state or federal assistance for the monthly payment for a rented house.

Interested in the local participation, the PMNF had initiated a consultancy process with questionnaires and meetings in the respective neighborhoods prior to the development of the municipal master plan (PMNF, 2016). After these meetings, the main concerns and issues were highlighted in every neighborhood that had to be considered for the master plan of the municipality, which included the description of risk areas. The final maps were validated through one week of public audiences where experts and citizens could take part. These are part of the urban planning of the municipality, the maps are available online and ready to download as shapefiles.

To evaluate the potential of higher levels of citizens participation for flood risk mapping, nine FG in seven different neighborhoods were organized, with 6–19 participants in each. The area selected was the same as the three official flood risk areas of INEA, plus four areas inside the municipality that were also heavily affected by the floods in 2011 according to the interviews (Fig. 5.1). The limits around the river were replicated according to the methodology of INEA, a HEC HMS hydrological model with an additional buffer zone. This same selection was used on the methodology determining risk perception for the population living in risk areas (Bustillos Ardaya et al., 2017:229): Rio Grandina, Cambiasca, Colonia, Corrego D'antas, Campo de Coelho, Barracao dos Mendes Salinas, and the city center of Nova Friburgo. The objectives of the FG were threefold: (1) drawing of collective timelines to encourage joint participation and memory, (2) producing participatory maps for later geo-referencing and for the development of a shared idea of space, and (3) identifying local problems and prioritizing risk reduction interventions as an exercise for decision-making.

For the mapping exercises, simplified satellite pictures of the neighborhoods were printed on A0 size paper sheets, where only roads, houses, and river paths were indicated (scales from 1:800 to 1:2000). Different from other suggested participatory mappings starting on blank sheets, these elements simplified location and digitization processes, making them geographically accurate. As a first step, existing elements (e.g. houses, public infrastructure, crops, springs) and problems in the area (e.g. landslides, droughts, water contamination, loss of springs, manipulation of the river) were marked with illustrated tokens and discussed. The tokens simplified the process and encouraged involvement; drawing or writing on the maps required extra skills not possessed by all participants. The maximum

water level experienced in floods and normal overflow were delineated together with evacuation routes and possible shelters. Finally, possible locations for important infrastructure, crops, group meetings, etc. were also marked and later prioritized with a simple voting technique. Qualitative data taken during the focus groups and the semi-structured interviews is presented in Section 5.3.2, divided between authority and power, communication and decision mode, and participants. The edited PM were digitalized, made available online for validation, and compared to the maps created by INEA and the PMNF in the nine evaluated areas using ArcGIS. The flood risk area, perimeter, evacuation route lengths, and quantity of evacuation points from the three sources are compared in Section 5.3.3.

5.3 Results

5.3.1 Participatory approaches of state and municipal institutions

We mapped 12 institutions in Rio de Janeiro and Nova Friburgo that are related to disaster risk reduction, all interviewed affirmed the existence of participatory processes, programs or schemes in their institutions. The Center for Natural Disaster Monitoring and Alert at state level (CEMADEN RJ) and regional level (CEMADEN Reg.) and the Secretariat of Civil Defense (SEDEC) in Nova Friburgo are responsible for articulating technical information received by federal and local governments related to possible climatic events at various levels. This information is mostly given by the State Institute for the Environment (INEA) working with river levels, climate, forests, maps, and related models, and the State Geological Survey Service of State (DRM) working with landslides and maps (GITEC / IP/ CODEX REMOTE, 2013). The Integrated Management of Disaster Risk project (GIDES) is a Brazil-Japan project led by JICA helping with the development of a disaster risk strategy in Brazil with a special focus on the mountainous region and some case studies in Nova Friburgo (JICA RJ D, 2016). The river basin agency for the Paraiba do Sul Basin (AGEVAP) works with water availability and consumption calculations, regulations, and organization of voluntary workers in the Paraiba, a basin part of the State. These four institutions working at State or regional level have fewer participants and more authority and power than the local or municipal institutions, as is common on the region.

Nova Friburgo Prefecture (PMNF) has created a master plan for the future development of the municipality in which disaster was one of the focus points to be considered for urban expansion after the events of 2011 (PMNF, 2016). They started with community meetings to discuss the important aspects to consider in a master plan, and once the plan was completed, it was presented to a public audience for comments and questions. Viva Rio (VR), an institution from INEA, works on the service to answer questions from the local population and offers courses related to environment and knowledge of the area. The Red Cross (RC), provides supplies and support to the population living in the risk areas, organizing weekly courses for first aid and rescue. The Municipal Civil Defense (MCD) organizes evacuation points in different neighborhoods and enables the population living in risk areas with training simulations using the sirens. The Network for risk management in Corrego D'antas (REGER) is a local initiative from the association of residents. These four institutions working on a municipal or local level have greater participation from the community but less decision-making power.

5.3.2 Varieties of participation

Participants

Defining the participants included in a DRR participatory program was the simplest dimension to be answered. According to the interviewed, few of the participation mechanisms mapped in this study developed by local and regional institutions reached the most inclusive level "citizens public sphere" on the scale (level 8), and cases of "random selection" (level 5) were conducted only by some universities doing research in the area (Table 5.2).

The case for the state participatory mapping (INEA), risk maps were developed by experts administrators (level 1) and presented to the public as pdf files. Since these maps were used for relocation purposes, the methodology was highly questioned and arguments such as "I have lived here for more than 30 years and even in 2011 my house was not affected" were common. The organized population (REGER), together with researchers from the Federal University of Rio de Janeiro (UFRJ) sought more information; however, even three years after the publication of the maps, the process used for their compilation was not entirely clear. On the other hand, as the maps were created by a temporarily hired consultancy agency (byEcologus) without involving INEA, they could not explain or argue about the process.

For the regional and local institutional participatory mapping, participation could reach high levels at specific points. Because of time limitations in the planning, the meetings of the municipality (PMNF) before the creation of the maps for the master plan were partially open to a self-selected subset of the population in the neighborhood (level 7). The participation was, therefore, limited to those who had the time, interest, and resources to attend on the given dates and it may be unrepresentative of the larger public. Nevertheless, after the meetings, the development of the maps was in charge of professional stakeholders (level 3), five experts of the municipality plus some external consultants. In the planning phase for the master plan, the PMNF collected 328 questionnaires for 26 neighborhoods and hold neighborhood meetings to gather information on the main problems, concerns, and suggestions of the population. While this could be considered as selfselection, the maps and decisions were taken by a small group of experts and then validated again by a larger population. To include more citizens, all shapefiles used for the master plan of the PMNF are available online at https://meioambientedigital.pmnf.rj.gov.br/.

In the case of the Author PM developed during the FG, the participation of the local population was included for the development of the maps. The people invited to the focus groups (FG) were selected according to their home location (population living in risk areas). Despite the flexibility in the organization of schedules, assistance was limited because of time constraints (level 7). The FG intended to include all the interested population. However, there was still limited attendance due to members of the population working at the time of the meetings or lacking interest because of the current low effectiveness of this process. Many surveyed said that they had previously participated in other projects where the results were not visible at all. However, suggestions were given to hold more FG every year to register and acknowledge changes in perception, areas, and necessities and inform these changes to more citizens.

The capacity building strategies of the Civil Defense (CD) and Red Cross (RC), amounting to small talks in public spaces, were described as "random selection", but this may not be a completely random selection from the total population, but the population circulating on a given public space on a given

day. In the network created for one of the neighborhoods (REGER), scientists from NF and RJ were specifically selected to participate in talks and meetings at which decisions about infrastructure and administration issues were made. Most state institutions and NGOs considered only the participation of experts, consultants, or trained people inside institutions, and this exclusivity is reflected in the middle of the triangle in Fig. 5.3A (up).

Table 5.2: Levels of participation mechanisms

Outcomes	Scale	Definition
INEA maps	1. (More exclusive)	Expert administrators: only projects where specific institutional charges are needed, low availability for participants, and limited positions
	2.	Elected representatives: managing projects from state institutions that can be removed or changed after governmental elections
PMNF maps	3.	Professional stakeholders: technicians and experts for consulting or research groups and private industries
	4.	Emergency services and scientific experts: voluntary participation in information and communication networks (REGER)
	5.	Random selection: research in affected areas according to population in specific households (UFRJ)
	6.	Trained volunteers: close work with the interested population, first aid, and evacuation courses (RC)
Author PM	7.	Self-selection, volunteers: participation in courses and training, highly dependent on time availability
	8. (More inclusive)	Citizens, public spheres, open or diffuse: federal, state or local census according to scope

Communication and decision mode

In the communication sphere, the least intense level after "implicit data collection"– where the participant is not even aware of his/her contribution – is "listen as spectator", which was presented most frequently in the studied cases (Table 5.3). However, aggregation and negotiation processes are harder to achieve and most of the public policies did not achieve this level of participation at the civil society level. There was a large gap between two levels: "expressing preferences" and "developing preferences". The only local case where "developing preferences" was achieved was in one community organization, where all members were also organizers of DRR and other activities. The schemes were horizontal, and they were free to change and adapt them (REGER). Even though the participation level improved, the lack of continuity in the communication processes hindered the decisionmaking mode.

Most of the decisions in state institutions, like INEA, are based on technical expertise, and only specialized and trained personnel take part (level1). The fact that an external consulting group elaborated the risk maps for the state institution, diminishes trust in the institution (INEA) and on crucial relocation decisions based on those risk maps. In the case of the PMNF, the meetings organized before the development of the master plan considered the participant as a spectator allowing only comments and questions at the end of every session. The civil society was highly encouraged to express their preferences (level 5), although the process to follow civil societies' preferences and integrate them into the contingency plan and the risk maps was unclear.

The participatory mapping in the FG was set at a community level, because mechanisms to encourage participants to exchange ideas and transform their views were mostly given independent from institutions, for example, in monthly community meetings. During discussions in community meetings, they expressed social issues and institutional disappointment, creating and bigger gap between institutions and people. Communication and decision making was easier among the local population with knowledge about the field. For the participatory risk maps, the maximal flooded area was based on the 2011 event, and details were discussed among people who had witnessed it. The PM was a case of explicit data collection (level 6) that may have been influenced by the low decision-making capacity they have expressed in their preferences.

Table 5.3: Levels of communication and decision mode

Outcomes	Scale	Definition
INEA maps	1. (Most intense)	Technical expertise: technicians of the agency hired for the development of the maps
	2.	Deliberate and negotiate: decision makers (Arranjo Institucional)
	3.	Aggregate and bargain: relation between state and municipal entities (CEMADEM, DC) and NGO with public power (Caritas)
	4.	Develop preferences: members of communities actively participating in projects (REGER)
PMNF maps	5.	Express preferences: community meetings, independent and organized by the municipality (PMNF, VR)
Author PM	6.	Explicit data collection: research for the public authorities where participation is needed (UFRJ, PM)
	7.	Listen as spectator: mostly media and one-way information sources as newspapers, news channels and communiques.
	8. (Least intense)	Implicit data collection: calculations based on existing data (aerial photographs of houses at risk)

Authority and power

This section considers how participants may influence actual decisions, change their perceptions, and the way they express their preferences. If they perceive a change in policies or actions after a participation process, there is a shift from personal preferences to collective decisions (Fung, 2006b:70). “Individual education” was the highest point for most state institutions for the civil society, the capacity building programs from the municipal CD, and some programs of VR. Direct authority was only seen in a community where the population can decide how to use the communal building (parties, courses, etc.). The three outcomes analyzed clearly show three levels of authority and power (Table 5.4).

As previously explained, the process for INEA risk maps included only the consulting group producing them (level 1). Whilst it is still unknown if they were aware of the final purpose of their risk map, they had a great deal of power. Those interviewed in INEA defended the relocation process with strong arguments about safety for people living in risk areas, while the arguments of the population being relocated were more complex. While some of them used optimism “if my house did not fall in such a big event, then it won’t fall at all”, others claimed to had calculated the maximum level of the river and the distance and altitude to their own houses to prove that they were out of a risk area. Political arguments like the relationship of the government with Odebrecht, the enterprise building the new houses in the relocation process, was mentioned more than once.

The case for the participatory maps in terms of authority and power was the lowest (level 7). People participating in these processes could only benefit from individual education and a communicative influence in relation to other participants. This was visible in Rio Grandina and Corrego D'antas, neighborhoods that had two focus groups working on the same geographical area. The dynamic was completely different in terms of the roles that the participants played, but the maps had only small differences.

Table 5.4: Levels of authority and power

Outcomes	Scale	Definition
INEA maps	1. (Most authority)	Direct authority: activities coming from centralized systems (CEMADEM, INEA)
	2.	Authority supervision: overlapping activities in undefined processes (CEMADEM Reg., DRM)
PMNF maps	3.	Co-govern: decisions taken for local action under low budget and regional organization (PMNF)
	4.	Advice consult: bottom-up advice from local to regional institutions (AGEVAP, CD, GIDES)
	5.	Communicative influence: mostly horizontal informal relations at state or municipal level
	6.	Personal benefits: research and information network (REGER)
Author PM	7. (Least authority)	Individual education: voluntary meetings and training (all participants on the RC and CD)

Three participation ranges

The comparison between state or regional institutions and municipal or local institutions reveals that local institutions had significantly more (+14.3%) participation of the local population, less authority and power (-9.9%) and almost the same communication and decision mode (+1.2%). Fig. 5.3A reveals two of the main processes for each state or regional institution and Fig. 3B shows two of the main processes related to participation for each local or municipal institution.

The definition and perception of participation varied considerably among the institutions interviewed. Even when all listed schemes or programs were considered participatory, the extremes are evident (Fig. 5.3). Being limited to a perception of the interviewed population, an actual evaluation of the schemes or programs could point some more differences. All those interviewed agreed on the importance of participation (somehow important to very important) but most of them had arguments on the barriers to interested and affected parties participating. As one representative of the municipal civil defense affirmed, "Just three or four come normally [to the simulations], most of them hear the alarm and stay home, we can't force them to come". For participatory processes that are mostly informative, like the simulations by the civil defense and capacity building programs from INEA and AGEVAP (Fig. 5.3A), the number of participants is less than programs from the Red Cross for first aid and emergency and the informative sessions of the community network of Corrego D'antas (REGER) that are continually taking place (Fig. 5.3B).

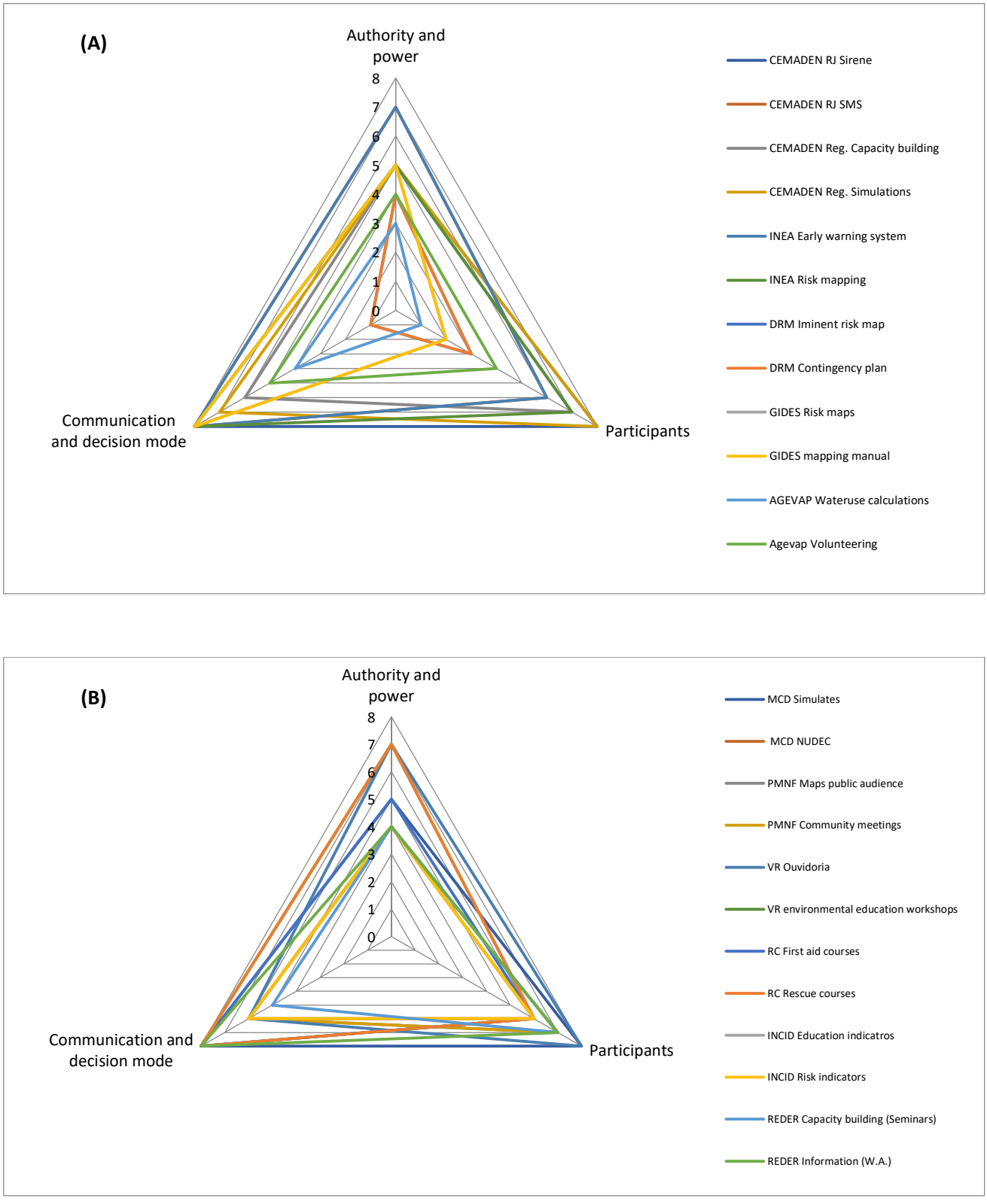


Figure 5.3 Participation level of regional (A) and local (B) institutions working on DRR according to Fung's (2006) triangle

5.3.3 Flood Risk Maps

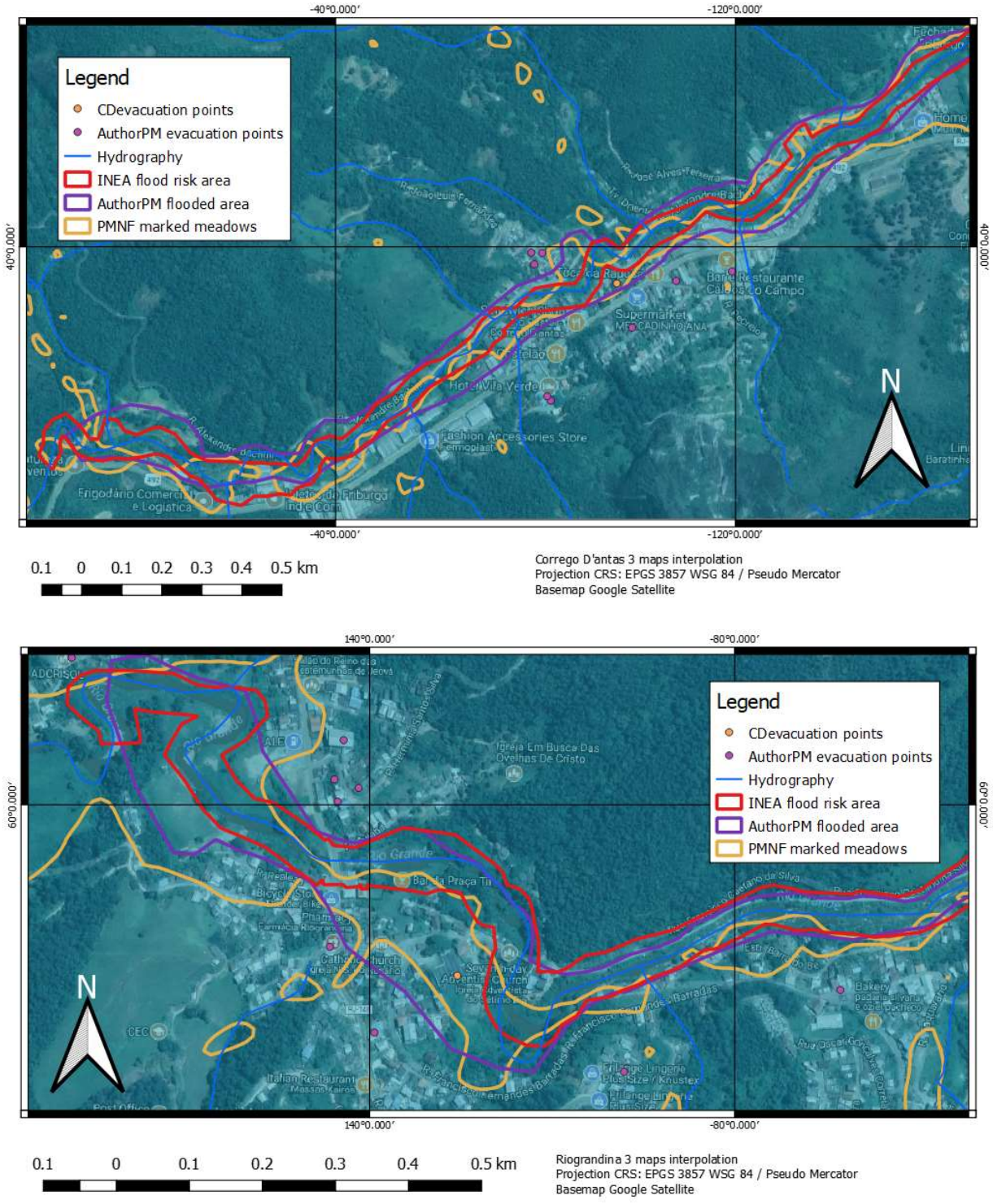


Figure 5.4 Map features of four sources: INEA, PMNF, CD, and Author PM in Corrego D'antas (above) and Riograndina (below)

The process of PMNF's master plan started in 2014. Questionnaires were filled in by different neighborhoods that inquired about risk areas, and diverse community meetings were organized to follow a participatory process to collect details on the needs and main concerns in the area. The meadows were marked and accounted as low-risk areas and had the least priority for future urban developments. The master plan was presented to the citizens in 2015 for questions and adjustments and still needs a final approval of the municipality. It will be the main source for further urban planning. According to our topographic survey, without defining levels for risk like INEA (high risk, low risk), the risk areas are bigger than those of INEA (Fig.5.4).

The participatory maps of the FG were developed for the same areas as the INEA FRM according to the process described in the methodology chapter. The digitalized maps were overlapped and quantitatively compared according to risk area size, evacuation points, and evacuation routes. The map shows the differences in risk area surface and the number of evacuation points (Fig. 4). The Civil Defense had created one evacuation point for every neighborhood that was already known to the population living in the risk areas. Nevertheless, in the FG maps, an average of five evacuation points was recognized per neighborhood (Table 5.5 and Fig. 5.5) according to capacity, closeness, and accessibility (evacuation routes).

The difference in the risk area of PMNF and INEA presented the most extreme results. This difference may be caused by the different methodology and purpose used in both cases. The area marked in the FG was frequently in between the area of INEA and the area of the PMNF and in most of the cases closer to INEA (Fig. 5). The area difference between the FG and INEA was smaller in neighborhoods where INEA risk maps were very well-known because of relocation conflicts or strong work of the state institution. Moreover, all details described by the population explained the areas that were frequently flooded and those that were underwater in 2011.

Table 5.5 Comparison of the values of the three flood risk maps (FRM)

Neighborhood name	River length considered (km)	Area considered (km^2)	INEA risk area (km^2)	FG risk area (km^2)	PMNF area (km^2)	FG Evacuation points	CD Evacuation points
Rio Grandina 1	1,70	0,89	0,10	0,14	0,21	5	1
Rio Grandina 2	1,70	0,89	0,10	0,14	0,21	9	1
Cambiasca	1,69	2,60	X	0,24	X	4	X
Colonia	1,62	6,80	X	1,28	X	2	X
Conquista	3,71	7,88	0,31	0,30	0,98	1	1
Corrego D`antas 1	2,57	2,98	0,16	0,27	1,45	5	1
Corrego D`antas 2	2,57	2,98	0,16	0,28	1,45	6	1
Campo do Coelho	1,33	0,96	0,10	0,09	0,13	5	1
Barrcao d. Mendez	1,62	1,05	X	0,18	0,24	2	1
Salinas	6,05	17,3	X	1,08	1,21	5	X
City center	2,09	3,81	X	0,31	0,51	4	X

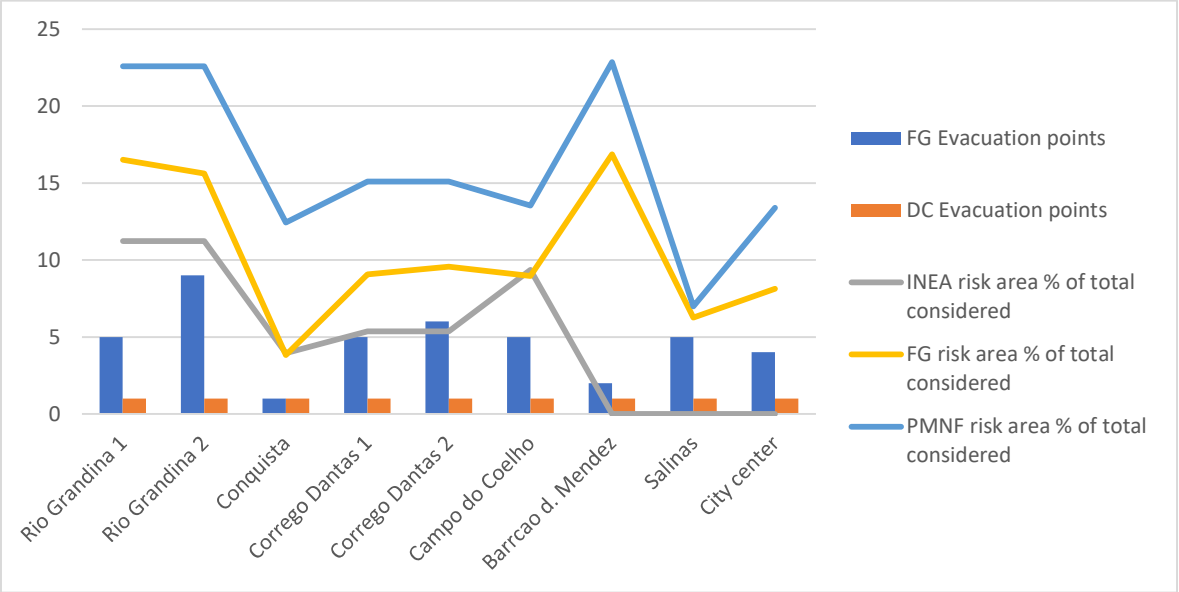


Figure 5.5 River length, areas and evacuation points differences in four methodologies

5.4 Discussion

Participation has the potential to improve decision-making and to increase acceptance, ownership, as well as commitment towards intended plans (Evers, 2012) and incorporate experience into new upcoming plans and development (Puppim de Oliveira and Fra Paleo, 2016). The resulting participation attributes to institutions at state and local level are comparable in general. Although the quantity of participants is much more limited at the state level, decision-making is higher. The risk maps of INEA created by a consultant group without the involvement of INEA workers is a good example. On the other hand, many capacity building programs at local level were available to everyone interested as a listener, with almost no capability of changing or deciding on content or processes. The community meetings of PMNF to collect important locations and aspects to consider for the planning maps of the municipality and the capacity building of the municipal CD on evacuation points (NUDEC) were local programs that included all the population willing to participate. They helped the communication process at horizontal and top-down approach but gave them a limited level of authority and power to reach a bottom-up system. This gap between the state and the local institutions grows once the local population is considered. This can be evident on examples where the population, aware of the lack of incentives from the institutions, create their own processes (e.g. community meetings) where the focus shifts to possible working ways “despite” state institutions. People living in risk areas have difficulties trusting and following larger institutions’ advice or programs and prefer to act according to neighbors and family advice (Bustillos Ardaya et al., 2017). Especially during the time after the 2011 event, many organizations collected people's opinions on participation and information about the affected areas without providing proper feedback on the outcome. “It doesn’t matter what we say at these meetings, we won’t be heard anyway, nothing is going to change” (speaker in the “desnaturalizacao de desastres” conference). The decisions taken with the flood risk maps were of great meaning for the local people involved (houses that had to be relocated by INEA)

and for landowners (enabling and disabling of new housing locations by the PMNF) among many other stakeholders.

A deeper comparison in the specific case of risk mapping showed quantitative spatial differences in terms of areas, points, and routes. In the participatory mapping, risk areas results were 0.12–0.014 km2 bigger than the official maps of INEA. Measures on risk areas were more complex and richer in details for participatory mapping, but had no influence in decision-making, as did those from INEA. More evacuation points were identified in the case of participatory risk mapping and, therefore, routes were totally different from those suggested by the civil defense. While area differences were rather small, details on the evacuation points and routes gave extra value to participatory maps. Participation by building the flood risk maps in the focus groups generated discussion, and the discussions in the mapping exercise allowed a level of detail on specific houses, on the best evacuation routes and the best points. The discussions also revealed specific reasons for the routes and evacuation points and clarified existing conflicts in the area. An increase in the quantity of the outputs, as some participation studies affirm (Kochskämper et al., 2016), is evident. Additionally, the FG allowed knowledge and experience exchange about basic prevention measures, evacuation procedures, and routes. In addition to the technical factors, such as area evacuation routes and points, there are further processes and indicators to evaluate in participatory processes. Perception, participants, communication, authority, and power are elements that also need to be evaluated. Finally, the qualitative comparison of these processes highlighted the difficulty of encouraging participation, finding times and places suited for all interested, and creating constructive dialogues instead of opening the discussion for criticism. The interaction dynamics between institutions and the population in other regions might be very similar, therefore, new approaches like those suggested in this document can be also useful for neighboring places. For instance, Teresópolis and Petrópolis (neighbor municipalities also affected by the same event) have also a network around local population and disaster risk reduction experts that tries to improve communication between institutions, government, and the affected population.

Benefits as the enforcement of legal rights could increase effective participation (Adhikari et al., 2014). Although the municipality was seeking a co-governing partnership with the population by undertaking consultation at the beginning of the master plan and a validation at the end, this was, in fact, “communicative influence” close to “advice/ consultation” where the municipality preserved its authority. This weakness in public deliberations may constrain legitimacy, being a critical factor and a weak multiplication of participatory channels (Gera, 2016; Merino, 2018). Two of the participants in the validation process complained, saying that “none of the suggestions we did at the beginning were actually considered”. As a response to this statement, an interviewee from the PMNF claimed that in the participatory process of the master plan of the municipality, “suggestions and complaints from the population were mostly focused on the effects of future urban planning on the participants’ private properties, looking only for personal benefit”.

Making an evident connection between participatory mechanisms and decisions, would improve the perception of the population and therefore increase participation. Coupling different mechanisms (computer models and participatory mapping) can show positive results; size and location of the risk areas are better understood (and in this specific case perception is not detached from official results) and details on specific aspects (e.g. evacuation mechanisms) increase. In addition to the technical details of the data obtained, there is an increase of justice, legitimacy, local authority, power, and

decision-making mode in the population on a small scale and understanding of the perceptions. Creating a big gap with Brazil, examples where co-governance is reached are mostly found in central Europe. The institutions and organizations in this research can rarely achieve higher levels of authority for the civil society, because it is not among their priorities, and because the resources for participatory processes are not available. The participatory mapping has potential to achieve co-governance if three major processes are accomplished: (1) a random selection of participants, among them experts reaching a (2) multi-level approach with dialogue, and specifically (3) knowing that their conclusions and work will indeed be transformed into policies or action.

5.5 Conclusions

Empowerment of the local population and collective decision-making is crucial in disaster risk reduction, especially in complex social-ecological systems. This study has described the participatory programs implemented by institutions working in disaster risk reduction in the State of Rio de Janeiro with three main participation criteria. The comparison between regional and local institutions in RJ revealed that it is easier for local institutions to obtain more participants from the civil society and create more levels of communication, nevertheless, the authority and power that they may have is very low. According to the results, there is a considerable difference between the participation level that institutions claim to have, and the level of participation detailed in the three dimensions of Fung's theory. Wider use of these three dimensions could lead to a better understanding of participation processes. In a first insight, further participatory processes from the state could include more members of the population in decisions and give more decision-making power to the population. Furthermore, more community organizations that are well established and functioning should be required to be included. Arguments from both sides about weak participation may imply an unclear definition of participation and lack of communication mechanisms. Mistrust, in this case, is a two-way multi-level problem led by the high perception of corruption, among other aspects.

Even though civil society and public power see participation as an important aspect of risk governance, legitimacy is lost as trust is missing in both directions. People's general perception is that the government works for other interests and it does not support of the locals, and institutions limit the reasons for low participation to a failure of the affected and interested parties to be present. The crucial point in this analysis is that the extent of influence of a municipality or local organization can hardly reach State, Federal or (even less) a policy level, so the participatory approach for risk governance is weakened as trust is diminished. On the other hand, the higher levels of authority that decide on further processes and actions have the lowest level of participation from and lack contact with the civil society.

Participatory approaches require time, human and monetary resources, proper methodologies, and adaptation according to participants and responses. Although further exploration of possible methodologies is still needed, this kind of work may be a justification and a guide for policymakers to encourage a combination of participation mechanisms in policies and regular procedures. We suggest that policymakers should give stakeholders, and especially civil society, a bigger space for dialogue and a better role in decision-making. However, it remains to be explored through further examples of participatory methods where the information and decisions made collectively are validated and applied to ensure efficiency in results and investment.

Chapter references

Adhikari, S., Kingi, T., Ganesh, S., 2014. Incentives for community participation in the governance and management of common property resources: the case of community forest management in Nepal. For. Policy Econ. 44, 1–9. https://doi.org/10.1016/j. forpol.2014.04.003.

Alexander, M., Priest, S., Mees, H., 2016. A framework for evaluating flood risk governance. Environ. Sci. Policy 64, 38–47. https://doi.org/10.1016/j.envsci.2016.06. 004.

Andrade, M.M.Nd., Bandeira, I.C.N., Fonseca, D.D.F., Bezerra, P.E.S., Andrade, Ád.S., Oliveira, R.S.d, 2017. Flood risk mapping in the amazon. In: Hromadka, T., Rao, P. (Eds.), Flood Risk Management. InTech.

Andrade, M.M.Nd., Szlafsztein, C.F., 2015. Community participation in flood mapping in the Amazon through interdisciplinary methods. Nat. Hazards 78, 1491–1500. https://doi.org/10.1007/s11069-015-1782-y.

APFM, 2006. Social Aspects and Social Aspects and Stakeholder Involvement in Integrated Flood Management. Associated Programme on Flood Management.

Ares, P., Risler, J., 2013. Manual de mapeo colectivo: Recursos cartográficos críticos para procesos territoriales de creación colaborativa, Tinta Limón, Buenos Aires. pp. 80.

BBC, 2011. Brazil Flood and Mudslide Deaths Rise As Rescue Goes on - BBC News. last access: 16 March 2017. http://www.bbc.com/news/world-latin-america-12180079.

Brown, G., Kyttä, M., 2018. Key issues and priorities in participatory mapping: toward integration or increased specialization? Appl. Geogr. 95, 1–8. https://doi.org/10. 1016/j.apgeog.2018.04.002.

Brown, G., Strickland-Munro, J., Kobryn, H., Moore, S.A., 2017. Mixed methods participatory GIS: an evaluation of the validity of qualitative and quantitative mapping methods. Appl. Geogr. 79, 153–166. https://doi.org/10.1016/j.apgeog.2016.12.015.

Bustillos Ardaya, A., Evers, M., Ribbe, L., 2017. What influences disaster risk perception?: intervention measures, flood and landslide risk perception of the population living in flood risk areas in Rio de Janeiro state, Brazil. Int. J. Disaster Risk Reduct. https:// doi.org/10.1016/j.ijdrr.2017.09.006.

Bustillos Ardaya, A., Miranda, J., Cho, M., 2015. Global umbrella for local rains: assessing implementation of the hyogo framework for action in Rio de Janeiro, Brazil. World Water Week Conference 25.

Canejo, A., 2015. Nº de vítimas em tragédia no RJ pode ser 10 vezes maior, dizem entidades. last access: 22 July 2016. http://g1.globo.com/rj/regiao-serrana/noticia/ 2015/08/entidades-apontam-subnotificacao-de-vitimas-da-tragedia-de-2011-naserra.html.

Cheung, W., Houston, D., Schubert, J.E., Basolo, V., Feldman, D., Matthew, R., Sanders, B.F., Karlin, B., Goodrich, K.A., Contreras, S.L., Luke, A., 2016. Integrating resident digital sketch maps with expert knowledge to assess spatial knowledge of flood risk: A case study of participatory mapping in Newport Beach, California. Appl. Geogr. 74, 56–64. https://doi.org/10.1016/j.apgeog.2016.07.006.

Coelho-Netto, A.L., Avelar, A.S., Fernandes, M.C., Lacerda, W.A., 2007. Landslide susceptibility in a mountainous geoecosystem, Tijuca massif, Rio de Janeiro: the role of morphometric subdivision of the terrain. Geomorphology 87, 120–131. https://doi.org/10.1016/j.geomorph.2006.03.041.

Custódio, A., Corrêa, T., 2012. Tragédia na Região Serrana teve mais mortos que o divulgado. EXTRA last access: 22 July 2016. http://extra.globo.com/noticias/rio/tragedia-regiao-serrana-2011/tragedia-na-regiao-serrana-teve-mais-mortos-que-divulgado-5685873.html.

da Mata, Siqueira, Antenora, Maria, 2015. Conflitos em contextos de desastres relacionados com as águas, Riscos de desastres relacionados à água. Defesa Civil, 2017. CapacitcaoBasicaemDefesaCivil: Histórico. last access: 26 January

2019. http://www.defesacivil.rj.gov.br/index.php/defesa-civil/escola-de-defesa-civil.

Evers, M., 2012. Participation in flood risk management: An introduction and recommendations for implementation, Rapport / Centrum för klimat och säkerhet, 2012:1. Centrum för klimat och säkerhet, Karlstads universitet, Karlstad, 20 s.

Evers, M., Jonoski, A., Almoradie, A., Lange, L., 2016. Collaborative decision making in sustainable flood risk management: a socio-technical approach and tools for participatory governance. Environ. Sci. Policy 55, 335–344. https://doi.org/10.1016/j.envsci.2015.09.009.

Ferreira, L.C., 2016. “Pior enchente” do Rio de Janeiro completa 50 anos. last access: 28 September 2016. http://www.ebc.com.br/noticias/meio-ambiente/2015/12/pior-enchente-do-rio-de-janeiro-completa-50-anos.

Folhes, R.T., Aguiar, A.P.Dd., Stoll, E., Dalla-Nora, E.L., Araújo, R., Coelho, A., Canto, O.d, 2015. Multi-scale participatory scenario methods and territorial planning in the Brazilian Amazon. Futures 73, 86–99. https://doi.org/10.1016/j.futures.2015.08.005.

Fontana, A., Frey, J., 1994. Interviewing The Art of Science. pp. 16.

Fung, A., 2006a. Varieties of participation in complex governance. Public Adm. Rev.66–75.

Fung, A., 2006b. Varieties of participation in complex governance. Public Adm. Rev. 66,66–75. https://doi.org/10.1111/j.1540-6210.2006.00667.x.

Gaillard, J.C., Monteil, C., Perrillat-Collomb, A., Chaudhary, S., Chaudhary, M., Chaudhary, O., Giazzi, F., Cadag, J.R.D., 2013. Participatory 3-dimension mapping: a tool for encouraging multi-caste collaboration to climate change adaptation and disaster risk reduction. Appl. Geogr. 45, 158–166. https://doi.org/10.1016/j.apgeog. 2013.09.009.

Gera, W., 2016. Public participation in environmental governance in the Philippines: the challenge of consolidation in engaging the state. Land Use Policy 52, 501–510. https://doi.org/10.1016/j.landusepol.2014.02.021.

GITEC / IP/ CODEX REMOTE, 2013. Concepção do arranjo Institucional e operacional para a gestão de risco de desastres no estado do Rio de Janeiro. 263 pp.

Hassenforder, E., Ducrot, R., Ferrand, N., Barreteau, O., Anne Daniell, K., Pittock, J., 2016. Four challenges in selecting and implementing methods to monitor and evaluate participatory processes: example from the Rwenzori region, Uganda. J. Environ.Manage. 180, 504–516. https://doi.org/10.1016/j.jenvman.2016.05.019.

IBGE, 2017. Estadistica dos estados. last access: 16 January 2017. http://www.ibge.gov.br/estadosat/perfil.php?sigla=rj.

INEA, 2011. Servicos emergenciais na macrodrenagem do municipio de nova friburgo e projetos do parque fluvial: Mapeamento de área com restricao a ocupacao, RJ Brazil.pp. 1.

IPCC, 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, pp. 582.

IRGC, 2005. Risk Governance: Towards an Integrative Approach. Geneva. pp. 157. IRGC, 2010. An_introduction_to_the_IRGC_Risk_Governance_Framework. pp. 24.

JICA RJ D, 2016. FAQ | Representação no Brasil | About JICA |. JICA, Rio de Janeiro.

Kochskämper, E., Challies, E., Newig, J., Jager, N.W., 2016. Participation for effective environmental governance? Evidence from Water Framework Directive implementation in Germany, Spain and the United Kingdom. J. Environ. Manage. 181,737–748. https://doi.org/10.1016/j.jenvman.2016.08.007.

Malve, O., Hjerppe, T., Tattari, S., Vaisanen, S., Huttunen, I., Kotamaki, N., Kallio, K.,Taskinen, A., Kauppila, P., 2016. Participatory operations model for cost-efficient monitoring and modeling of river basins–A systematic approach. Sci. Total Environ.540, 79–89. https://doi.org/10.1016/j.scitotenv.2015.06.105.

Merino, R., 2018. Re-politicizing participation or reframing environmental governance?: beyond indigenous' prior consultation and citizen participation. World Dev. 111,75–83. https://doi.org/10.1016/j.worlddev.2018.06.025. Munich Re, 2016. Worst Natural Disasters Statistics |

Munich Re. last access: 28 September 2016. https://www.munichre.com/en/reinsurance/business/non-life/natcatservice/significant-natural-catastrophes/index.html.

Nehren, U., Schlüter, S., Raedig, C., Sattler, D., Hissa, H., 2019. Strategies and Tools for a Sustainable Rural Rio De Janeiro, Springer Series on Environmental Management. Springer, Cham, Switzerland 1 online resource (xxxii, 513.

Pachauri, R.K. and Mayer, L. (Eds.) Climate Change 2014: Synthesis Report, Intergovernmental Panel on Climate Change, Geneva, Switzerland, 151 pp., 2015.

Pahl-Wostl, C., Lebel, L., Knieper, C., Nikitina, E., 2012. From applying panaceas to mastering complexity: toward adaptive water governance in river basins. Environ. Sci. Policy 23, 24–34. https://doi.org/10.1016/j.envsci.2012.07.014.

PMNF, 2016. Plano Diretor da Prefeitura Municipal de Nova Friburgo. last access: 17 January 2017. meioambientedigital.pmnf.rj.gov.br.

Puppim de Oliveira, J.A., Fra Paleo, U., 2016. Lost in participation: how local knowledge was overlooked in land use planning and risk governance in Tōhoku, Japan. Land Use Policy 52, 543–551. https://doi.org/10.1016/j.landusepol.2014.09.023.

Renn, O., 2012. In: Chadwick, R.F. (Ed.), Risk Governance in a Complex World, in: Encyclopedia of Applied Ethics, 2. ed. Elsevier, Amsterdam, pp. 846–854.

Samodra, G., Chen, G., Sartohadi, J., Kasama, K., 2018. Generating landslide inventory by participatory mapping: an example in Purwosari Area, Yogyakarta, Java. Geomorphology 306, 306–313. https://doi.org/10.1016/j.geomorph.2015.07.035.

Schensul, J.J., 2013. Focused Group Interviews, Enhanced Ethnographic Methods. pp. 33.

Sharma-Wallace, L., Velarde, S.J., Wreford, A., 2018. Adaptive governance good practice: show me the evidence!. J. Environ. Manage. 222, 174–184. https://doi.org/10.1016/j.jenvman.2018.05.067.

UN WATER, 2016. Integrated Monitoring Guide. last access: 7 February 2017. http:// www.unwater.org/publications/publications-detail/en/c/434399/.

UNDRR, 2015. Sendai Framework for Disaster Risk Reduction 2015–2030. pp. 37.

UNFCCC, 2016. Participatory Mapping: Presenting Spatial Knowledge of Local Communities: Mapping for Rights. last access: 18 August 2018. https://www. mappingforrights.org/participatory_mapping.

UNISDR, 2012. Como Construir Cidades Mais Resilientes: Um Guia para Gestores Públicos Locais, Escritorio das nacoes unidas para reducao de riscos de desastres. pp. 102.

Universidade Federal de Santa Catarina, 2012. Capacitação Basica em Defesa Civil.

Usón, T.J., Klonner, C., Höfle, B., 2016. Using participatory geographic approaches for urban flood risk in Santiago de Chile: insights from a governance analysis. Environ. Sci. Policy 66, 62–72. https://doi.org/10.1016/j.envsci.2016.08.002.

Van der Molen, F., 2018. How knowledge enables governance: the coproduction of environmental governance capacity. Environ. Sci. Policy 87.

Verbrugge, L.N.H., Ganzevoort, W., Fliervoet, J.M., Panten, K., van den Born, R.J.G., 2016. Implementing participatory monitoring in river management: the role of stakeholders' perspectives and incentives. J. Environ. Manage. https://doi.org/10.1016/j.jenvman.2016.11.035.

Wehn, U., Evers, J., 2015. The social innovation potential of ICT-enabled citizen observatories to increase eParticipation in local flood risk management. Technol. Soc.42, 187–198. https://doi.org/10.1016/j.techsoc.2015.05.002.

Wehn, U., Rusca, M., Evers, J., Lanfranchi, V., 2015. Participation in flood risk management and the potential of citizen observatories: a governance analysis. Environ.Sci. Policy 48, 225–236.

World Bank, 2000. SELECTED WEB RESOURCES AND DOCUMENTS on Participatory Processes. pp. 5.

World Bank, 2012. Avaliação de Perdas e Danos: Inundações e Deslizamentos na Região Serrana do Rio de Janeiro - Janeiro de 2011.

SIXTH CHAPTER

6 Discussion of disaster risk governance factors

Applying risk governance frameworks in dynamic environments.

6.1 Introduction

The present chapter aims to analyze and discuss the results of the previous chapters and extract important operationalization mechanisms through existing risk governance frameworks. The applicability of RG frameworks in dynamic environments are discussed together with important factors to improve RG in rapidly changing environments like the case study. Furthermore, the frameworks' value for adaptation and resilience are analyzed from a multidisciplinary and integrative perspective to answer the main question: "**how are existing concepts about disaster risk governance translated into potential and applied ways of dealing with dynamic environments in the context of disaster risk reduction?**"

The discussion is based on the definition of dynamic environments and risk governance in the introduction chapter, the results of the literature review, and the results of the field research described in chapters 2 to 5. The latest and most recurrent elements introduced in risk governance frameworks, exposed in the first chapter, answered the first sub-question: "What are the main variables and factors of RG presented in papers and frameworks and how do they interact?" The enablers and constraints of the application and operationalization of the main elements (research and knowledge, stakeholder involvement, and communication) in disaster risk governance processes are presented in the second chapter. After clarifying the combination of methods for the case study in the third chapter, the fourth chapter answers a second question: "What are the applied ways of dealing with dynamic environments?", which is discussed in the reflection on the applicability chapter (6.2). The results of the last question, "What are the potential elements to deal with dynamic environments?" are given in the fifth chapter and discussed at the end of the chapter.

The main factors described in the literature review (Fig. 1.7) are supported with examples of the case of Rio de Janeiro (RJ) and the risk governance changes after the catastrophe of 2011 in the mountainous region. For the exemplification of the case of RJ, the research uses the results described in chapters 2 to 5; 391 surveys of the population living in risk areas, 19 semi-structured expert interviews held with the main authorities of four state agencies in RJ (Centre for Natural Disasters Monitoring and Alert: CEMADEN, the State Secretary for Environment: INEA, the Geologic Service: DRM, and the mineralogy department: CPRM) and five municipal or regional agencies (Civil Defense: DC, Water Basin Agency: AGEVAP, Rio Rural and the Municipal Prefecture of Nova Friburgo: PMNF) working on disaster risk reduction (DRR). The focus groups, participatory mapping, and workshop described in chapter 3 also contribute to this analysis. This information gathered, and methods applied between August 2014 and December 2016 in Portuguese, were focused on the governance of the agencies concerned in relation to floods, landslides, and droughts, perceptions, the process of information gathering and generation, and the relations and communication between institutions and the population. Official documents released by these agencies were also considered.

6.2 Reflection of the applicability of risk governance factors in dynamic environments

6.2.1 Research and Knowledge

After the events of 2011, data and information increased in quantity and sources, more monitoring stations were installed for INEA, satellite images were used, and NGOs interviewed, and data collected from the population. On the other hand, the organization of this data, and its transformation to

general knowledge among the population was missing. Using the DIKW model (Rowley, 2007), there were weak points in the development from data to wisdom. Local informal groups were also built; principally for reconstruction of the bridges, roads, and houses, and for mutual support as victims or survivors of the disaster. Additionally, these networks were good sources of important information. Some existing associations were strengthened on this subject and some of the groups got in touch with the institutions working in the area to create more information and working networks.

The amount and quality of research will define the existing information and potential knowledge of a system for further implementation and communication. For example, around 200 private companies are specialized in environmental monitoring in Germany. Local and national governments manage and make available environmental databases with high resolution and precision, resulting in thousands of studies and interpretations. On the other hand, despite being one of the most monitored states in Brazil, uncertainty in RJ is evident, as there is a lack of data or knowledge in view of a desire or incentive to act (van Asselt, 2005) and its relation to DE. The comparison between monitoring stations' density between states like RJ and Amazonas brings extreme results. Hydrometric stations registered by the Water National Agency (ANA) give a total of one station every 7.205 km^2 in the Amazonas while there is one station every 57 km^2 in RJ. This difference is an example of uncertainty in the information gathering for environmental modeling. Scientific uncertainty is a considerable problem, as information is seldom sufficient (Schumann, 2011), models and predictions are weak (Pielke et al., 2013), and decision making is poorly supported (Leskens et al., 2014; Schumann, 2011). Official information sources in the DRR communication process are governmental and non-governmental authorities, media figures, and friends or relatives (Lindell and Perry, 2004b). In RJ, forecasting models are not officially implemented, and water level values are directly set as alert standards. This kind of robust model is a forecast-independent alternative that seeks to achieve a reasonable level of accuracy with known facts (Walker et al., 2013). Robustness should also occur when independent sources reach a reliable result (Pasini and Mazzocchi, 2015), nevertheless these may also create more complexity in the very probable scenario that results are generated by different sources. The INEA obtains information from monitoring stations provided by different international projects; different station functioning systems create different ways of reading and coding data into a telemetry system that has to be standardized, creating many possible resulting formats. Even if constant formal environmental research reduces uncertainty (Collins, 2013), it does not necessarily reduce ambiguity (Fekete, 2012).

In addition to Rio de Janeiro's inner complex and constantly changing research and knowledge state, external factors such as mining activities, industry growth, cattle insertion, changing crops, monocultures, and changes in water cycle processes must also be considered and measured. In socio-political systems, new forms of management induced by the insertion of new political parties change the administration patterns, actors, and the long-term institutional networks. As an example, rapid economic growth in RJ characterized by industrialization processes and recent oil field discoveries in Campos caused immigration from other states. The urban and peri-urban area in many municipalities expanded causing several secondary businesses to open (IBGE, 2001) and housing areas to expand. Monitoring and planning of new settlements, industry, and production areas should happen every four to seven years through a master plan. This master plan for future developments is behind in most of the municipalities.

Complexity, scientific uncertainty, and socio-political ambiguity are bounded in social and environmental systems (SES). Removing one of these factors, as suggested in some frameworks, does not occur in these cases. Changes are so rapid that limitations in risk knowledge and genuine uncertainty always need to be considered. At the same time, environmental risks may not be isolated as would be the case of laboratory accidents; they mostly affect different social groups and are managed by different organizations. This multivalence will increase as the number of actors involved increases, increasing polarization and ambiguity. Since the relation of the actors, casual links, and cause-effect links are also constantly changing, the uncertainty, ambiguity, and, therefore, complexity are all high. Despite this ambiguity increase, inclusion in the knowledge building processes is very important (Scolobig et al., 2015).

6.2.2 Stakeholder involvement

Stakeholder analysis and involvement helps the adaptation of new technologies and processes (Johnson et al., 2004), controls influences of power on DM, empowers the poorer and weaker (Chambers, 1994), and provides robust knowledge that improves communication quality (Berkes, 1999). Even if expanding participation and rebalancing interest group representation can be problematic (Rothstein, 2004), there are theories available to improve it and add a bottom-up perspective. Elaboration of the Manu Model (Nakmofa and Lassa, 2009) or community-based organizations in emergency planning, like bidirectional communication, engage the vulnerable population in the planning process (Klaiman et al., 2010). Stakeholder involvement and participation have gained an important place in risk governance analysis. Compared to the first results, the level of detail in new participation mechanisms (Henriksen et al., 2018), multiple stakeholders' networking (Trias et al., 2018), trust and knowledge requirements (Dobbie et al., 2016), and conflicts or side effects (Mees et al., 2018; Scolobig et al., 2015) is greater in the latest publications.

After the floods and landslides of 2011, a document was created describing the institutional arrangement of DRR in RJ, representing roles and hierarchies of the main institutions (Consórcio GITEC / IP/ CODEX REMOTE, 2014). Consisting of six chapters, the document is a description of governmental institutions, structures, functions, and improvement suggestions. The document was created with the participation of several institution workers. The ideal is an organizational communication framework that combines information with rhetoric and dialectic thinking and is affected by what the people in the institutions do together and how they act towards people outside of the company (Heath, 1994). In such a complete analysis, it is believed that both sides of the communication chain must be present, society as a receiver and, ideally, also as a producer of knowledge. Reed simplified the process, adding social network analysis and confirming that stakeholder involvement can bring significant gains in adaptability and flexibility (Reed et al., 2009). Among the experts interviewed, all claimed the existence of participatory mechanisms in their institutions, and three recognized the necessity for more stakeholder involvement. In the case of INEA, more incentives for people to continuously stay informed (webpage or message alerts) and in the case of the civil defense more participation in rescue and evacuation courses (INEA expert, 2015a).

Knowledge sharing with neighbors, informal support networks, active collaboration, community engagement, participatory techniques, and community-based organizations improve cognitive learning (Evers et al., 2016) and fight the effects of mistrust and strengthen the links from coexisting at a local level (Klaiman et al., 2010). Ultimately, credibility and trust define further processes to be

taken (Danzig et al., 1958; Dow and Cutter, 1998). Trust can be defined as "(1) a tightly interconnected and intertwined set of affective beliefs about institutional behavior and (2) how competent the institution appears to be" (Metlay, 1999). With limited data, trusting institutions that may not have access to the whole truth, but just a level of expertise and experience, may be a challenge (Collins and Evans, 2002). For instance, in RJ people place more trust in warnings that come from the same neighborhood or family members than official sources (Bustillos Ardaya et al., 2017; INCID expert, 2015). The broader governance context and power constellations may be defining trust and, therefore, stakeholder involvement (Wamsler, 2017). Consequently, the lack of involvement in the deliberation of cause-effect chains is also likely to worsen risk perception (Aldoory et al., 2010; Scolobig et al., 2015). Several publications after 2015 related stakeholder involvement with the political system, either as the system that must enforce participation or just an enabler of participatory mechanisms. Economic freedom, government effectiveness, corruption, and democracy are some of the key factors (Zuo et al., 2017). Inclusive governance on the basis of self-organizing units, is presented as the most promising concept to meet disaster risk governance challenges (Scweizer and Renn, 2019). Still, the conditions needed to effectively contribute to sustainable risk management in every case vary and need to be further explored (Challies et al., 2016).

6.2.3 Communication

Changing environments and complex problems require a great deal of dialogue, exchange, and deliberation to assess existing knowledge and casual connections in a top-down and bottom-up approach (Fekete, 2012; Mauelshagen et al., 2014). As a central factor in RG, communication and community involvement creates ownership, empowerment (Palenchar and Heath, 2007), and further valid and reliable findings of a complex nature of a given risk (Schelfaut et al., 2011). Furthermore, communication enhances adaptive capacity (Munene et al., 2018), triggers social change, improves multi-stakeholder understanding (Fekete, 2012), and enhances social identification, environmental values, in group injunctive norms, and self-stereotypes, improves inter-agency coordination (Smith and Dowell, 2000), facilitates DM (Horita and Albuquerque, 2013), and makes it more effective (Kapucu and Garayev, 2011). Even official documents, such as the US National Research Council's "Red Book" (Stern and Fineberg, 1996) and the Royal Society Study Group report (Royal Society Study Group on Risk Assessment, 1992), recognize communication and stakeholder involvement as important for risk reduction. The Hyogo Framework for DRR (ISDR, 2005) and the Sendai framework (UNDRR, 2015) give high priority to risk and hazard warning and also new insight on application possibilities. The sources analyzed establish the great advantages of communication for RG and DRR but do not entirely explain how better communication is achieved. Brazil is emerging as an active, strong research country and has become a focal point of interest for technology research and open-access (OA) information (Education Worldwide, 2013; The Economist, 2011), allowing free access to weather and river basin data online. Nevertheless, the information technology practitioner community, key players in developing and implementing the early warning system and the open access (OA) information, seems unaware of this OA movement (Costa and Leite, 2008). This may be caused by lack of funds, information spreading, and stakeholder participation and perception, lack of consistency, and over- or under-regulation causing misuse of technologies.

After the conventional transmission model of Shannon and Weaver (Shannon and Weaver, 1964 [©1949) and their mathematical transmission model of communication improved by Berlo (Berlo, 1960) as sender, receiver, message, and channel model, the importance given to communication in

risk assessment and risk reduction has grown considerably in the 1990s. Renn, Levine, followed by Leiss, Metlay and then Wisner introduced and developed risk communication, effectiveness, trust, and confidence concepts, respectively (Metlay, 1999). As it is not isolated and is part of a transdisciplinary subject, scientific positivism combined with social constructivism of involved actors are present in a continuous dialogue for collaborative DM (Renn, 1992). For this study, the definition of (Craig, 1999) and his constitutive metamodel theory was used to find a middle point and engage more concepts into dialogue on the practice of communication for RG. Going further from the basic sender, receiver, message, and channel schema, more elements were taken into consideration: effect (Lasswell, 1948), feedback (Schramm, 1954), translation of the information to a user-friendly language (White et al., 2001), positive social identity language (Seyranian, 2014), credibility of the given information (Danzig et al., 1958), perception and interpretation of the received information (Mileti and Peek, 2000), and trust, either as "willingness to rely on another" or as "positive expectations" (Rousseau et al., 1998).

In the communication process, the capacity of the receiver to understand must be considered; just getting institution information does not necessarily trigger action. Even in a case scenario where sources are trustworthy, information is clear and accurate, and the channel is direct, the effective outcome will depend on the knowledge, reaction, and perception of the PAP (Dorasamy et al., 2013; Hiwasaki et al., 2014). After receiving information, a process of perception and interpretation begins, where frames of actions are created by receivers (Mileti and Peek, 2000). In RJ, receiver characteristics include extreme values, such as demographic attributes, pre-existing knowledge or religious beliefs, perceived costs of compliance (Mayhorn and Collins McLaughlin, 2014), bounded rationality (Herbert, 1955), framing, past experience, time and risk pressures, base rate, and political and economic factors (Doyle et al., 2014). Based on this situation, what may count as a risk for some sectors is an opportunity for another sector, or even a faith or destiny that must be accepted. The framing is to be done in the different types of risk of natural hazards (sudden or slow, local or international, relevant or irrelevant) and the meaning for different stakeholders. In rural RJ, a long-lasting flood is a low risk for a house owner who must temporarily move to a second floor and a serious risk for a farmer who loses a year of crop production and, therefore, a year's income. For the municipality, this may be an opportunity to obtain financial aid from the federal government, since the number of people affected is one of the main parameters to access federal financial resources. It was well known among the experts interviewed that communication plays a very important role for risk reduction, but it was also recognized that there is a lot of work to do to improve it, both with the population and with other institutions.

6.2.4 Decision making and implementation process

Most of the government policies in Brazil are focused on management rather than appraisal. Most of the existing documents in RJ institutions are focused on the roles inside the institutions (e.g. institutional arrangement), tangible results (e.g. infrastructure plans), and administrative aspects (e.g. human resources and salaries). This is not only the case where greater focus is placed on establishment and functioning than on the development of action plans (Mashi et al., 2018). Even during budget cuts in 2016 technical staff were released first to keep administrative staff working. According to three of the people interviewed, the bureaucracy and administrative complexity are so high and centralized in Brazil that more resources and time are required by institutions as "control for all institutions increases as corruption increases" (INEA expert, 2015b). In Brazil, political inequality,

as the capacity to deal with natural hazard-related risk reduction at the municipal level, is highly related to decentralization (Dubrow, 2015). This necessity for decentralization in processes for DRR is a relatable issue for many Latin American countries (Ruiz-Rivera and Melgarejo-Rodríguez, 2017).

As previously defined, decision making (DM) is strongly limited by perception. Aspects about the appraisal of the population or inside an institution are present informally, but they are not to be found in documents or official research despite its importance. Even with limitations, well-designed and effective DM processes may be defined as a cognitive process that leads to a rapid, responsive, and evidence-based selection of a belief or action among several alternative possibilities (Gouldson et al., 2009). In the short term, a crucial point for DM is the alarm. With the decision based on the data taken by the stations and other measurements, a technical DM has to be adopted (Collins and Evans, 2002). As previously mentioned, the INEA early warning system issues a flood alarm, based on water level information coming from automatic telemetric stations. Information about water level over the maximum safe level is given to the meteorological technician who decides if the alarm is to be issued or not (CCO - INEA expert, 2014). Civil defense in the municipalities uses the same alarm for emergency response (CEMADEM expert, 2014). Being dependent on only one official source of information, the DM system in the state is far from robust, according to the definition of Pasini and Mazzocchi (Pasini and Mazzocchi, 2015), although there is a degree of flexibility that allows the person responsible to decide in the field about the best measures to be taken. The spatiality of the data (few monitoring stations in big areas), and failure of alarms over time has changed the perceptions of the PAP and, therefore, their reliability.

Long-term DM has more time to analyze inputs and influences. Decisions about a new safe housing location, replantation in a risk area, or even settlement reallocation can all involve more factors and create more ambiguity. The federal project “Minha casa minha vida”, reallocating people living in risk areas, has created a great deal of polarity and ambiguity in the last few years. Sources and methods used to define risk areas and the planning of the facilities to be provided are critically questioned by some and eulogized by others. Independent social movements affirm that the actual conflicts in some residential areas could have been avoided by letting the people participate in the planning phase of the buildings (INCID expert, 2015). Some basic requirements of climate-resilient urban development, such as the inclusion of the poor population and implementation of building standards, could improve decision-making results like relocation and land readjustment (Bustillos Ardaya et al., 2019; Mitchell et al., 2015).

6.2.5 Adaptation to rapid changes and methods for coping with uncertainty

Iterative adaptive capacity is a key factor for risk governance. At this point, it may be important to differentiate between the adaptation of policies and institutions and the adaptation of the population who would possibly be affected. There are two types of adaptation: 1) planned adaptation that is the result of deliberate decisions, and 2) autonomous adaptation that is not a planned response but an internal reaction, the latter may be compared with resilience (Burton, 2004; Schipper and Burton, 2009). Different adaptive planning strategies include dynamic strategic planning (Neufville, 2000), adaptive policymaking (increasing robustness of the basic policy and contingency planning) (Kwakkel et al., 2010), robust policies (Hamarat et al., 2014), flexible and transparent adaptive strategies (Assmuth et al., 2010; Lempert and Collins, 2007), and an adaptation policy framework (Kalame et al., 2011). All of these are related to the first type of adaptation. Planned and self-organized adaptation

of stakeholders (Rasmus Kløcker Larsen et al.) and adaptive capacity (Asare-Kyei et al., 2015; Parsons et al., 2016) are related to the second type of adaptation. Flexible and robust strategies are more plausible for autonomous adaptation than for planned adaptation. After a disaster, adaptation will be "forced" on the affected people, who must make fast decisions and reorganize their household as convenient. On the other hand, adaptation for institutions working on disasters requires rearrangements, organization, planning, human and monetary resources, bureaucracy processes, and implementation time. In the case of RJ, the lack of constancy and failures in the implementation time are the main reasons why many projects were abandoned two to three years after the catastrophe of 2011 (DRM expert, 2015). For example, projects working on social awareness and forest recovery had limited funding, people were less active, and projects were no longer considered to be relevant since the main problem shifted to drought.

For the second type, autonomous adaptation, there was a significant gap between affected neighborhoods. While some had no formal organization, others had regular meetings in a community house and were taking part in research with state universities. "They organized funds for infrastructure and information to create a big network of experts working in their neighborhood" (INCID expert, 2016). Independent groups on social media like Facebook and What's App were created for risk-related issues. This confirms (Castells, 2013) theory; with so many rapid changes in communication networks and languages, media is the space where power is being played and power relationships are being profoundly modified. The budget for civil defense expansion in 2015 was €15,000, several thousand less than previous years (GRJ, 2015), and some of the trained personnel are no longer working for the program. This not only increases uncertainty, but also diminishes trust and stakeholder participation. Since DRR is not the main concern of the local population, these scenarios must be linked to other subjects and opportunities related to the area where interaction already occurs such as community groups, parent meetings, and schools, and there is a great potential for religious groups in RJ.

As a mechanism for adaptation, participatory assessment (Ceccato et al., 2011), uncertainty awareness (knowledge), and inclusion of decision-makers (Leskens et al., 2014) are also possible. Flexible strategies can be put forward for risk cases in climate change adaptation, which it is suggested do not fully commit to a policy or course of action until more information is available (Dobes, 2008). Worldwide data on adaptive responses to climate change clarify where internal institution networks were created (Aylett, 2015). Nevertheless, for dynamic environments, reliable information is not only difficult to obtain, with low uncertainty levels, but is also constantly changing. Waiting for more information to be available may bring considerable delay to all processes. Instead, a set of possible methods and strategies could better increase the flexibility of policy (Bustillos Ardaya et al., 2018). The mountainous area has 70% of its territory under severe risk of landslides (Soares Macedo, 2014) and, with increasing urbanization processes, there is a great deal of ambiguity when deciding new settlement areas or protection measures. Autonomous adaptation for recurrent floods was very good, but institutions had to undertake considerable work on adaptation after the landslides that provoked a catastrophe in 2011. A major issue now is to adapt all these capacities and resources for the droughts that have been affecting the area since 2014. This constant change, not only in magnitude but also in types of risk, requires greater levels of adaptation: rapidness in resources reallocation (less bureaucracy) and, again, more communication spaces (more trust).

To improve effectiveness in the informal communication within the risk area's population and trigger action, the information has to be frequently repeated, confirmed (Mileti and Peek, 2000), constantly delivered and socially validated, and inclusive between strangers (BERGER and CALABRESE, 1975). In this way, the necessity for renovation and constant creation of scenarios and opportunities for knowledge exchange between stakeholders is evident for an effective RG, but not emphasized. Many projects targeted involvement and participation after the tragedy of 2011. Civil defense expanded its strategy from a focus on response to an approach for stakeholder preparedness. Capacitation of the population and groups in the neighborhoods were active for a couple of years. Once the resources were spent, problems of floods were no longer evident, and the drought was taking place, these groups ceased to actively function and the collaborative networks were no longer used (Association leader, 2015). Also, civil defense performed its first simulation in Nova Friburgo city on 22 September 2014, three-and-a-half years after the catastrophe, with a low participation rate. After the events of 2011, the Brazilian government had an annual investment of more than €11 million in the automatic real-time early warning system, creating constant data on water levels for all state river basins through telemetric monitoring stations (INEA, 2015). Four years after the disaster event, the webpage providing real-time information free online (www.inea.infoper.net) is no longer the same and the SMS system ceased to send constant messages. Additionally, a low number of people have access to this information.

6.2.6 Meeting points of the population and civil society

As a way of dissemination of the results and closure of the field study each year, workshops were held in 2014, 2015, and 2016, grouping the population living in the risk areas with institutional authorities working there. The discussions held during the workshops were linked to the results of the surveys, interviews, and focus groups and wrap up what was done during this time. Giving space for dialog between locals and institution workers, the workshops intended to exchange perceptions based on a systematic vision construction methodology. Local perceptions of the public institutions were limited in knowledge, and the relation of public power with civil society requires considerable improvement. The main problem between the civil society and public power aspects is communication and it is translated into many components. As Luhmann highlighted, communication is the autopoietic model of social systems and, therefore, they need to be considered as a dynamic auto-constructive process. Important differences are apparent between the results of civil society and public power in the individual and the collective evaluations.

In the individual evaluation, "capacity building and knowledge" was the most relevant component for civil society, with 15% of the votes of relevance. Following capacity building, two components had 13% of relevance selected, communication and dialog, and participation and integration. Two components had 11% of the votes of relevance, community organization and social movements, and organization and cooperation (or partnership). In the collective evaluation, and after the discussion on all sides, education and communication were the main aspects to consider and prioritize, with two-thirds of the participants' votes. Humanization of public power had 4% votes in the individuals' consideration but was discussed for a long time during the debate. As part of a humanization process, the use of less technical language was mentioned. The remaining question was to define the line between lowering the bar, simplifying aspects, and changing the language to reach the maximum population or investing in education, building capacity and knowledge among the population so they can better understand the available information.

For public power, capacity building was in the first place of the individuals' priorities (19% of the votes of relevance), most of them were related more to the technical capacity of the public workers than the capacity building of the civil society. Collectively, technical capacity was mentioned between the three main aspects as a conclusion. Civil society was mostly encouraged to build capacity and obtain information from the institutions, while a main aspect for public power was to build the capacity of technical issues. Communication between locals and institutions was not mentioned among the individual priorities but the suggestion that communication is mostly given in one way and is a responsibility of civil society was discussed. In the individual results, nobody attributed to public power the work on awareness and perception, while awareness gained 5% of the priority results for civil society.

It was evident that there is a need for more possibilities of dialog between institutions and civil society that influence the way decisions are made. Decisions at the local level and validation of the results should be supported. In the case of Brazil, this is even harder because of the dimensions of the organizations, complexity of the system, dynamicity of arrangements (e.g. political), and lack of trust.

The participant workshops allowed local stakeholders to understand the system, highlight specific improvement possibilities, and through discussion understand the main concerns of institution representatives. Although a suggestion for governmental institutions, and even being time and resource intense, there is great potential in the use of these combined methodologies to increase participation. The increase of communication among stakeholders and the use of local information both for public power and research create stronger networks that contribute to the development of DRR and RG among others.

6.3 Enablers and constraints of concepts, applied and possible disaster risk governance

Operationalization of disaster risk governance (DRG) concepts is a gap hardly covered in most of the frameworks and can be very different from case to case. The second and third research sub-questions in this study aimed to cover this gap for a specific case and explore the application of DRG in Rio de Janeiro. As previously discussed, factors in DRG like stakeholder involvement, trust, and communication are the hardest factors to apply in the state. Dynamic environments that significantly change governance when changing government lose trust among stakeholders, and communication networks must be continuously rebuilt. In this case study, those factors require much more time and work to improve DRG than, for example, research and knowledge or adaptation to rapid changes. In countries like Germany and Switzerland participatory processes are systematically integrated, and trust, in terms of assured reliance on institutions or organized groups, is present.

According to the results presented in chapter five and answering the third research sub-question, the possibilities of improving DRG presented by the population living in risk areas are different from the possibilities presented by the institutions. Since the gap between the concepts presented in the frameworks and what its being applied in the field is so great, there are more possible ways to improve DRG. This does not mean that once more concepts are being applied, there will be fewer possible ways to improve DRG, but that the possibilities presented by different stakeholders will have more elements in common. This may also be a result of improved communication; appraisal and discourse

have a common pattern among stakeholders. In other words, there is a general idea of the possibilities, including agreement and conflicting points among stakeholders.

As presented, dynamic environments (DE) are shaped mainly by rapid changes and uncertainty. Because of the uncertainty brought by DE, information changes constantly, ambiguity increases, and complexity is more evident. In this study, a quantitative and critical literature review was performed and revealed that stakeholder involvement for adaptation capacity, research and knowledge, effective communication, constancy in time, and physical spaces for those factors are crucial variables for risk governance. Individual and institutional adaptation measures (management) will be determined by knowledge and perception (appraisal) and information networks (power networks). Integral knowledge and understanding of the complexity of dynamic systems is the foundation of risk governance, while effective communication of this understanding is the driver and central core. Some of these concepts require much more time and work in order to be applied in the research areas analyzed, which can be very different from case to case. Likewise, the possibilities of applying these concepts may vary significantly among different research areas. The operationalization of DRG frameworks relies on examples like the case study presented in this study.

The problems identified are that most of the frameworks recognize the importance of communication and integration but do not prioritize the necessity of constancy, temporal reiteration, and renovation, nor the scale of physical spaces in actual dynamic environments. This chapter argued that some of the concepts need to be redefined. Also, for the application of the concepts, it highlighted the importance of a rotation (reiteration, renovation, and constancy) that communicates, monitors, and directs adaptation capacity. More methodologies and applications for stakeholder involvement and communication network enforcement were proposed, suggesting indicators to measure the different factors and adaptation increase. However, this does not change the overall conclusion that frameworks provide a strong and useful basis for decision-makers that can improve risk governance.

Chapter references

Aldoory L, Kim J-N, Tindall N. The influence of perceived shared risk in crisis communication: Elaborating the situational theory of publics. Public Relations Review 2010;36(2):134–40.

Asare-Kyei DK, Kloos J, Renaud FG. Multi-scale participatory indicator development approaches for climate change risk assessment in West Africa. International Journal of Disaster Risk Reduction 2015;11:13–34.

Assmuth T, Hildén M, Benighaus C. Integrated risk assessment and risk governance as socio-political phenomena: a synthetic view of the challenges. Sci. Total Environ. 2010;408(18):3943–53.

Association leader. O trabalho em Corrego Dantas depois da tragédia. Nova Friburgo, 2015.

Aylett A. Institutionalizing the urban governance of climate change adaptation: Results of an international survey. Urban Climate 2015;14:4–16.

BERGER CR, CALABRESE RJ. SOME EXPLORATIONS IN INITIAL INTERACTION AND BEYOND: TOWARD A DEVELOPMENTAL THEORY OF INTERPERSONAL COMMUNICATION. Northwestern Univeristy 1975.

Berkes F. Sacred ecology: Traditional ecological knowledge and resource management. Philadelphia, Pa.: Taylor & Francis; 1999.

Berlo DK. The process of communication: An Introduction to Theory and Practice. New York: Holt, Rinehart and Winston; 1960.

Burton I. CLIMATE CHANGE AND THE ADAPTION DEFICIT. Climate change building the adaptive capacity 2004.

Bustillos Ardaya A, Evers M, Lars R. Integrated Participatory Methodologies for Disaster Risk Reduction - Tools to analyze complex systems through participatory processes in Brazil. 1st ed.: Springer; 2018.

Bustillos Ardaya A, Evers M, Ribbe L. What influences disaster risk perception?: Intervention measures, flood and landslide risk perception of the population living in flood risk areas in Rio de Janeiro state, Brazil. International Journal of Disaster Risk Reduction 2017.

Bustillos Ardaya A, Evers M, Ribbe L. Participatory approaches for disaster risk governance?: Exploring participatory mechanisms and mapping to close the communication gap between population living in flood risk areas and authorities in Nova Friburgo Municipality, RJ, Brazil. Land Use Policy 2019;88:104103.

Castells M. Communication power. 2nd ed. Oxford [u.a.]: Oxford University Press; 2013.
CCO - INEA expert. Sistema de aviso temprano. Modo de operação e falhas. Rio de Janeiro, 2014.
Ceccato L, Giannini V, Giupponi C. Participatory assessment of adaptation strategies to flood risk in the Upper Brahmaputra and Danube river basins. Environmental Science & Policy 2011;14(8):1163–74.
CEMADEM expert. Defesa Civil, Nova Friburgo. Nova Friburgo, 2014.
Challies E, Newig J, Thaler T, Kochskämper E, Levin-Keitel M. Participatory and collaborative governance for sustainable flood risk management: An emerging research agenda. Environmental Science & Policy 2016;55:275–80.
Chambers R. Participatory rural appraisal (PRA): Challenges, potentials and paradigm. World Development 1994;22(10):1437–54.
Collins AE. Applications of the disaster risk reduction approach to migration influenced by environmental change. Environmental Science & Policy 2013;27:S112-S125.
Collins HM, Evans R. The Third Wave of Science Studies: Studies of Expertise and Experience. Social Studies of Science 2002;32(2):235–96.
Consórcio GITEC / IP/ CODEX REMOTE. CONCEPÇÃO DO ARRANJO INSTITUCIONAL E OPERACIONAL PARA A GESTÃO DE RISCO DE DESASTRES NO ESTADO DO RIO DE JANEIRO: ontrato SEPLAG-RJ no 9/2013 para Serviços de Consultoria; 2014.
Costa SMS, Leite FCL. Brazilian Open Access Initiatives: Key Strategies and Actions. Toronto, Canada: Conference on Electronic Publishing; 2008.
Craig R. Communication Theory as a Field. International communication association 1999;2:119–61.
Danzig ER, Thayer PW, Galater LR. The Effects of a Threatening Rumor on a Disease Stricken Community. National Research Council Disaster Study No. 10. Washington, DC; 1958.
Dobbie MF, Brown RR, Farrelly MA. Risk governance in the water sensitive city: Practitioner perspectives on ownership, management and trust. Environmental Science & Policy 2016;55:218–27.
Dobes L. Getting Real about Adapting to Climate Change: Using 'Real Options' to Address the Uncertainties. Agenda: a journal of policy analisys and reform 2008;15(3):55–69.
Dorasamy M, Raman M, Kaliannan M. Knowledge management systems in support of disasters management: A two decade review. Technological Forecasting and Social Change 2013;80(9):1834–53.
Dow K, Cutter SL. Crying wolf: Repeat responses to hurricane evacuation orders. Coastal Management 1998;26(4):237–52.
Doyle EEH, McClure J, Paton D, Johnston DM. Uncertainty and decision making: Volcanic crisis scenarios. International Journal of Disaster Risk Reduction 2014;10:75–101.
DRM expert. O trabalho de DRM na redução de riscos. Rio de Janeiro, 2015.
Dubrow JK. Political Inequality in the Age of Democracy: Cross-national Perspectives: Routledge Taylor & Francis Group; 2015.
Education Worldwide. Bildungsforschung in Brasilien, 2013. http://www.education-worldwide.de/Educational-Research-in-Brazil-7007_e.html (accessed June 03, 2015).
Evers M, Jonoski A, Almoradie A, Lange L. Collaborative decision making in sustainable flood risk management: A socio-technical approach and tools for participatory governance. Environmental Science & Policy 2016;55:335–44.
Fekete A. Safety and security target levels: Opportunities and challenges for risk management and risk communication. International Journal of Disaster Risk Reduction 2012;2:67–76.
Gouldson A, Morton A, Pollard SJT. Better environmental regulation--contributions from risk-based decision-making. The Science of the total environment 2009;407(19):5283–8.
GRJ. Portal Transparencia: Orçamento Fácil, 2015. http://www.transparencia.rj.gov.br/transparencia/faces/OrcamentoTematico/orcamentoFacil?_afrLoop=1262380790100000&_afrWindowMode=0&_adf.ctrl-state=mb81pcofu_24 (accessed June 03, 2015).
Hamarat C, Kwakkel JH, Pruyt E, Loonen ET. An exploratory approach for adaptive policymaking by using multi-objective robust optimization. Simulation Modelling Practice and Theory 2014;46:25–39.
Heath RL. Management of corporate communication: From interpersonal contacts to external affairs. Hillsdale, N.J: Erlbaum; 1994.
Henriksen HJ, Roberts MJ, van der Keur P, Harjanne A, Egilson D, Alfonso L. Participatory early warning and monitoring systems: A Nordic framework for web-based flood risk management. International Journal of Disaster Risk Reduction 2018;31:1295–306.
Herbert SA. JSTOR: Biometrika, Vol. 42, No. 3/4 (Dec., 1955), pp. 425-440, 1955. http://www.jstor.org/discover/10.2307/2333389?sid=21105504054231&uid=4&uid=2&uid=3737864 (accessed March 02, 2015).
Hiwasaki L, Luna E, Syamsidik, Shaw R. Process for integrating local and indigenous knowledge with science for hydro-meteorological disaster risk reduction and climate change adaptation in coastal and small island communities. International Journal of Disaster Risk Reduction 2014;10:15–27.
Horita FE, Albuquerque JP. An Approach to Support Decision-Making in Disaster Management based on Volunteer Geographic Information (VGI) and Spatial Decision Support Systems (SDSS). Supporting Disaster Management using VGI and SDSS 2013.
IBGE. Tendências demográficas: Uma análise dos resultados da sinopse preliminar do censo demográfico 2000. Rio de Janeiro: IBGE; 2001.
INCID expert. Cidadania ativa na redução de riscos. Nova Friburgo, 2015.
INCID expert. Desnaturalizacao dos desastres no estado de RJ. Brasília, 2016.
INEA. Flood alert system, 2015. undefined (accessed June 03, 2015).
INEA expert. Functioning of the INEA alert system. Rio de Janeiro, 2015a.
INEA expert. O trabalho da INEA em redução de riscos. Rio de Janeiro, 2015b.
ISDR. Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters, 2005. http://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf.

Johnson N, Lilja N, Ashby JA, Garcia JA. The practice of participatory research and gender analysis in natural resource management. Natural Resources Forum 2004;28(3):189–200.
Kalame FB, Aidoo R, Nkem J, Ajayie OC, Kanninen M, Luukkanen O et al. Modified taungya system in Ghana: A win–win practice for forestry and adaptation to climate change? Environmental Science & Policy 2011;14(5):519–30.
Kapucu N, Garayev V. Collaborative Decision-Making in Emergency and Disaster Management. International Journal of Public Administration 2011;34(6):366–75.
Klaiman T, Knorr D, Fitzgerald S, DeMara P, Thomas C, Heake G et al. Locating and communicating with at-risk populations about emergency preparedness: the vulnerable populations outreach model. Disaster Med Public Health Prep 2010;4(3):246–51.
Kwakkel JH, Walker WE, Marchau VAWJ. Adaptive Airport Strategic Planning. EJTIR 2010;3(10):249–73.
Lasswell HD. The structure and function of communication in society. The Institute for Religious and Social Studies 1948:215–28.
Lempert RJ, Collins MT. Managing the risk of uncertain threshold responses: comparison of robust, optimum, and precautionary approaches. Risk Anal. 2007;27(4):1009–26.
Leskens JG, Brugnach M, Hoekstra AY, Schuurmans W. Why are decisions in flood disaster management so poorly supported by information from flood models? Environmental Modelling & Software 2014;53:53–61.
Lindell MK, Perry RW. Communicating environmental risk in multiethnic communities. Thousand Oaks, Calif: Sage; 2004.
Mashi SA, Obaro O, Inakani AI. Disaster risks and management policies and practices in Nigeria: A critical appraisal of the National Emergency Management Agency Act. International Journal of Disaster Risk Reduction 2018.
Mauelshagen C, Smith M, Schiller F, Denyer D, Rocks S, Pollard S. Effective risk governance for environmental policy making: A knowledge management perspective. Environmental Science & Policy 2014;41:23–32.
Mayhorn CB, Collins McLaughlin A. Warning the world of extreme events: A global perspective on risk communication for natural and technological disaster. Safety Science 2014;61:43–50.
Mees H, Alexander M, Gralepois M, Matczak P, Mees H. Typologies of citizen co-production in flood risk governance. Environmental Science & Policy 2018;89:330–9.
Metlay D. Institutional Trust and Confidence: A Journey into a Conceptual Quagmire. Social Trust and the Managemant of Risk 1999:100–16.
Mileti DS, Peek L. The social psychology of public response to warnings of a nuclear power plant accident. Journal of Hazardous Materials 2000;75:181–94.
Mitchell D, Enemark S, van der Molen P. Climate resilient urban development: Why responsible land governance is important. Land Use Policy 2015;48:190–8.
Munene MB, Swartling ÅG, Thomalla F. Adaptive governance as a catalyst for transforming the relationship between development and disaster risk through the Sendai Framework? International Journal of Disaster Risk Reduction 2018;28:653–63.
Nakmofa Y, Lassa J. Community Based Approach to Disaster Risk Reduction and Climate Change Adaptation Towards Sustainable Livelihood: Ten Years Experiences From PMPB Kupang. Journal of Ntt Studies 2009;1(2):136–45.
Neufville Rd. Dynamic strategic planning for technology policy. IJTM 2000;19(3/4/5):225.
Palenchar MJ, Heath RL. Strategic risk communication: Adding value to society. Public Relations Review 2007;33(2):120–9.
Parsons M, Glavac S, Hastings P, Marshall G, McGregor J, McNeill J et al. Top-down assessment of disaster resilience: A conceptual framework using coping and adaptive capacities. International Journal of Disaster Risk Reduction 2016;19:1–11.
Pasini A, Mazzocchi F. A multi-approach strategy in climate attribution studies: Is it possible to apply a robustness framework? Environmental Science & Policy 2015;50(0):191–9.
Pielke RA, Adegoke J, Niyogi D, Kallos G, Seastedt TR, Hossain F. Climate vulnerability: Understanding and addressing threats to essential resources. VOL5. VULNERABILITY OF WATER RESOURCES TO CLIMATE. Amsterdam: Elsevier Academic Press; 2013.
Rasmus Kløcker Larsen, Åsa Gerger Swartling, Neil Powell, Brad May, Ryan Plummer, Louise Simonsson et al. A framework for facilitating dialogue between policy planners and local climate change adaptation professionals: Cases from Sweden, Canada and Indonesia.
Reed MS, Graves A, Dandy N, Posthumus H, Hubacek K, Morris J et al. Who's in and why? A typology of stakeholder analysis methods for natural resource management. Journal of environmental management 2009;90(5):1933–49.
Renn O. Concepts of risk: A classification: In Krimsky, Sheldon (Hrsg.): Social theories of risk. Westport, Conn: Praeger; 1992.
Rothstein HF. Precautionary Bans or Sacrificial Lambs? Participative Risk Regulation and the Reform of the UK Food Safety Regime. Public Administration 2004;82(4):857–81.
Rousseau DM, Sitkin SB, Burt RS, Camerer C. NOT SO DIFFERENT AFTER ALL: A CROSS-DISCIPLINE VIEW OF TRUST. Academy of Management Review 1998;23:393–404.
Rowley J. The wisdom hierarchy: Representations of the DIKW hierarchy. Journal of Information Science 2007;33(2):163–80.
Royal Society Study Group on Risk Assessment. Risk: analysis, perception, measurement. London: Royal Society; 1992.
Ruiz-Rivera N, Melgarejo-Rodríguez CR. Political inequality and local government capacity for Disaster Risk Reduction: Evidence from Mexico. International Journal of Disaster Risk Reduction 2017;24:38–45.
Schelfaut K, Pannemans B, van der Craats I, Krywkow J, Mysiak J, Cools J. Bringing flood resilience into practice: The FREEMAN project. Environmental Science & Policy 2011;14(7):825–33.
Schipper L, Burton I. The Earthscan reader on adaptation to climate change. London, Sterling, Va.: Earthscan; 2009.
Schramm W. How communication works. In W. Schramm (Ed.), The process and effects of communication. Urbana, Illinois: University of Illinois Press 1954:3–26.
Schumann A. Flood risk assessment and management: How to specify hydrological loads, their consequences and uncertainties. Berlin, Heidelberg, New York: Springer; 2011.

Schweizer and Renn 2019 (PDF) Governance of Systemic Risks for Disaster Prevention and Mitigation. Available from: https://www.researchgate.net/publication/335339691_Governance_of_Systemic_Risks_for_Disaster_Prevention_and_Mitigation [accessed May 12 2020].

Scolobig A, Prior T, Schröter D, Jörin J, Patt A. Towards people-centred approaches for effective disaster risk management: Balancing rhetoric with reality. International Journal of Disaster Risk Reduction 2015;12:202–12.

Seyranian V. Social identity framing communication strategies for mobilizing social change. The Leadership Quarterly 2014;25(3):468–86.

Shannon CE, Weaver W. The mathematical theory of communication. Urbana: University of Illinois Press; 1964 [©1949.

Smith W, Dowell J. A case study of co-ordinative decision-making in disaster management. Ergonomics 2000;43(8):1153–66.

Soares Macedo I. Revisão do Plano Diretor de Nova Friburgo 2014, 2014. http://www.planodiretornf2014.org/ (accessed February 23, 2016).

Stern PC, Fineberg HV. Understanding risk: Informing decisions in a democratic society. Washington, D.C.: National Academy Press; 1996.

The Economist. Go south, young scientist, 2011. http://www.economist.com/node/17851421 (accessed June 03, 2015).

Trias AP, Lassa J, Surjan A. Connecting the actors, discovering the ties: Exploring disaster risk governance network in Asia and the Pacific. International Journal of Disaster Risk Reduction 2018.

UNDRR. Sendai Framework for Disaster Risk Reduction 2015 - 2030: United Nations Office for Disaster Risk Reduction; 2015.

van Asselt MBA. The complex significance of uncertainty in a risk era: logics manners and strategies in use. Int. Risk Assessment and Management 2005;5(2/3/4):125–58.

Walker WE, Haasnoot M, Kwakkel JH. Adapt or perish: a review of planning approaches for adaptation under deep uncertainty. Sustainability 2013;5:955–79.

Wamsler C. Stakeholder involvement in strategic adaptation planning: Transdisciplinarity and co-production at stake? Environmental Science & Policy 2017;75:148–57.

White GF, Robert KW, Burton I. Knowing better and losing even more: the use ofknowledge in hazards management. Environmental Hazards 2001;3:81–92.

Zuo W, Zhu W, Wang F, Wei J, Bondar A. Exploring the institutional determinants of risk governance: A comparative approach across nations. International Journal of Disaster Risk Reduction 2017;24:135–43.

SEVENTH CHAPTER

7 Disaster risk governance applied to Rio de Janeiro

Conclusions and outlook.

7.1 Conclusions

The research question "what are the theoretical, actual, and possible ways of dealing with dynamic environments like Rio de Janeiro in the context of disaster risk governance?" was answered across several steps described along the 6 chapters, starting with the definition of dynamic environments and the decomposition of risk governance in all its factors in the introduction chapter. Based on the solid case of Rio de Janeiro in relation to management and appraisal described in the second chapter, this dissertation studied and compared the components of disaster risk governance from a top-down and a bottom-up perspective with interdisciplinary approaches from the social and natural spheres through a methodology described on the third chapter.

The results in the fourth chapter showed that the population living in the risk areas considered in the study rely more on the influence of their neighbors, family, and friends than the influence of public institutions. On the other hand, institutions have very few programs or projects that consider or call for the participation of the local organized population. In addition, the level of participation they consider does not reach a decision-making level, as described in the fifth chapter. Even though the path to achieving a visible change in DRR systems in a bureaucratic country like Brazil is long and tedious, participatory processes applied during the field research seem to allow the construction of stronger communication and knowledge networks among institutions and civil society that may reduce mistrust in the long term. Solid challenges and issues that must be considered in dynamic environments like Rio de Janeiro State, such as the empowerment of the local population and collective decision-making, were further clarified in the sixth chapter.

7.1.1 Disaster risk reduction management and appraisal

The second chapter introduced the case of the implementation of the Hyogo Framework for Action in the state of Rio de Janeiro, presenting the post-HFA debate and what was a base for the Sendai Framework for action (2015–2025). Rio de Janeiro presented an interesting case study in the context of DRR implementation because of the combination of extreme hazard and lack of proper risk governance, preventable man-made disasters, along with the implications of climate change and rapid urbanization. This study builds on the awareness of regional level implementation and capacity building of both Brazil's decision-makers and the international community (e.g. UNISDR and IRGC).

Brazil demonstrates its capacity to establish a legal environment, setting up institutions for DRR actions, and bringing DRR to the national agenda. Nevertheless, at the state level (taking a resourceful state as an example) it seems that financial resources, communication networks, and long-term goals for DRR rooted at local and community levels are not enough. Likewise, the characteristics of a dynamic environment like land-use planning for reducing risk in favelas and addressing vulnerable sectors of the population and their livelihoods before and after a disaster are lacking enforcement. Because of the time considered between designing a policy (fastest and potentially less expensive action in the process) and its effective implementation in a real context, implementation at a local level has many more gaps than implementation at a state or national level. In the long run, implementation requires, therefore, much more support in terms of technology, resources, and time invested from institutions (e.g. financial resources) and from the civil society (e.g. human resources). The transition of a policy to implementation seems to potentially increase time and financial cost. "Strengthening disaster preparedness at all levels", and "reducing underlying factors", more

specifically the fourth and fifth actions of the framework, both related to policy implementation, are harder to accomplish because of all the existing levels, local underlying factors, and the dynamic environment in a country as big and complex as Brazil.

Once the mostly top-down system of Brazil and its approach to an international sphere was clarified, the necessity to explore the local level approach was evident. Chapter three explained how different interdisciplinary methodologies were combined to evaluate the existing technology and processes to create the information about the risk areas, the appraisal of the population living there, the approaches of state and municipal authorities, and the conflicts and communication struggles among them. Even though there were multiple possibilities of combining them, five methods were selected to illustrate the contributions of each method to the process. Participant observation, questionnaires, and interviews helped in the stakeholder selection and individual consultation processes. To explore group interactions and communication, different activities in the focus groups and participant workshops allowed a better understanding of the communication, active involvement, shared decision-making and, therefore, the constraints of the management.

The appraisal of the population living in flood risk areas was described in chapter four, where the results of the questionnaires were presented. After analyzing and correlating six factors around appraisal, the results show that flood risk perception is principally influenced by past experiences with disaster risk and demographic factors such as age, followed by the influence of civil society (in this case neighbors, friends, and family) and in one of the last places is the influence of public institutions. The chapter focused on two factors, the influence of civil society and the influence of public institutions, since they can be worked on, changed and, therefore, improved. Most of the population surveyed takes no part in the programs, courses, or information networks offered by public institutions because of mistrust and skepticism. Trust and credibility among residents are stronger in neighborhoods where representatives or population organizations are continuously working, communicating and exchanging information (e.g. associations strongly linked to research projects, universities, and even political parties); civil society's influence is in this case stronger.

The fourth chapter also evaluated the determinant variables defining perceptions of specific hard intervention measures (e.g. dams, contention walls, and channels) against soft intervention measures (e.g. capacity building, networking, and emergency response plans) applied by the local population and public institutions. Although inflexible, static, and unadaptable, hard intervention measures are generally perceived as better solutions for disaster risk reduction among civil society and public institution members due to visibility, clear investment, and defined implementation time. On the other hand, soft intervention measures related to communication on response and evacuations require more organization and time to reach a wider population and outcomes are hard to measure and evaluate. Nevertheless, disaster risk and vulnerability are dynamic and require constant adaptation, new technologies that promote hard and soft intervention measures, and constant renewal of approaches from institutions and society. Since the influence of the organized population is greater than the influence of the institutions for appraisal, interest and trust, participation of the civil society in soft intervention measures is essential to cope with dynamism. There is a great potential for institutions to work with the organized elements of society on issues such as social capital, expansion and strengthening of information networks, improvement of knowledge sharing, and simultaneously education and building awareness of the ongoing local problems. Empowerment

of the local population and collective decision-making is crucial in disaster risk reduction, especially in complex social-ecological systems.

To further explore the relation of institutions and the local population, interviews and focus groups were implemented in different neighborhoods of the municipality. Chapter five described the participatory programs implemented by institutions working in disaster risk reduction and classified them under the three dimensions of participation created by Fung (2006), according to the perception of authorities answering the interviews. A comparison between regional (i.e. state) and local (i.e. municipal) institutions revealed that it is easier for local institutions to obtain more participants from the civil society and create more levels of communication, nevertheless, the authority and power that they may have is very low. The results show a considerable difference between the participation level that institution employees claim (unclear definition of participation), and the level of participation detailed in the three dimensions (participants, communication level, and authority and power). People's general perception is that the government works for other interests and does not support the local population, and institution representatives limit the reasons for low participation of the local population to a failure of the affected and interested parties to be present when opportunities arise. Arguments from institutions and the local population about weak participation may imply a lack of communication mechanisms that do not allow participation, and increase mistrust, that in this case is a two-way multi-level problem led by the high perception of corruption and low participation of the civil society, among other aspects.

This chapter also found that the extent of influence of a municipality or local organization hardly reached state, federal, or (even less) national policy level, so the participatory approach for risk governance is weakened as the results do not reach action levels and trust is diminished. Likewise, higher levels of authority that decide on further processes and actions have the lowest level of participation, and in some cases lack contact with civil society. To set an example, the fifth chapter connected participatory mechanisms and decisions with a participatory mapping exercise. Although an example, different participatory mechanisms (computer models and participatory mapping) show quantitative and comparative results. In participatory mechanisms important details of specific aspects increased (e.g. locations and routes for evacuation), and the size and location of the risk areas were better defined and understood and, in this specific case, perception was not detached from official results. Adding to the technical details of the data obtained, there was an increase of legitimacy, local authority, power, and decision-making mode in the local population on a small scale, and on the other hand, there was a better understanding of the perception of the population. Participatory approaches require time, human and monetary resources, proper methodologies, and adaptation according to participants and responses, but they may improve the perception of the population and, therefore, increase participation.

7.1.2 Disaster risk governance and communication

The workshops held in 2014, 2015, and 2016 created discussion between the population living in the risk areas and institutional authorities working there. The sixth chapter presented the results of the workshops and analyzed the application of the IRGC framework in the Brazilian context. The participatory workshop allowed local stakeholders to understand the system, point out specific improvement possibilities, and through discussion understand the main concerns of institution

representatives. The results revealed important differences between civil society and public power in the individual and the collective evaluations.

In the participatory workshop, capacity building and knowledge was the most relevant component for civil society and public power. Civil society was mostly encouraged to build capacity and obtain information from the institutions, while a main aspect for public power was to build the capacity of technical issues. Communication between locals and institutions was not mentioned among the individual priorities but it was discussed that communication is mostly one way and was a responsibility of the civil society. The need for more dialog possibilities between institutions and civil society that influence the way decisions are made is evident. Decisions at the local level and validation of the results should be supported. Complexity, in the case of Brazil, is aggravated because of the dimensions of the organizations, structure of the system, dynamicity of arrangements, and (especially) lack of trust.

The quantitative and critical literature review of the IRGC framework discussed in the sixth chapter concluded that stakeholder involvement improves adaptation capacity, research and knowledge, effective communication, and constancy in time and physical spaces for those factors that are crucial variables for risk governance. Individual and institutional adaptation measures (management) will be determined by existing knowledge, perception (appraisal), and information networks (power networks). Most of the frameworks recognize the importance of communication, integral knowledge, and understanding, but do not prioritize the necessity for constancy, temporal reiteration, and renovation, nor the scale of physical spaces in actual dynamic environments. Frameworks provide a strong and useful basis for decision-makers that have the potential to improve risk governance. Added to this, a rotational process of the framework that monitors and redirects adaptation capacity suggested by the IRGC was highlighted and more methodologies for stakeholder involvement and communication network enforcement were proposed, setting those described in this study as an example.

In very dynamic, strongly centralized, and extremely bureaucratic countries like Brazil, the enforcement of stakeholder involvement and insertion of a bottom-up approach may not only empower the local population, but can also increase resilience and adaptation. The state of Rio de Janeiro and especially peri-urban areas still have a long way to go with participation and communication measures. Accurate data collection processes, frequent information, and experience exchanges may increase connection and improve communication, increasing the state's capacity for adaptation and setting it as an example for other states and regions. Considering the time and monetary implications, policymakers should prioritize these aspects in countries and areas strongly affected by rapid changes and uncertainties. Methodologies for participation and stakeholder involvement must be constantly tested for different contexts and areas to contribute with knowledge exchange processes and increase networks in both a bottom-up and top-down perspective.

7.2 Methodological limitations

Despite the great effort to analyze the ways of dealing with dynamic environments, there are some methodological caveats to be considered. In addition to the understanding of barriers and enablers of implementation of international frameworks, more research is needed to assess the outcomes brought by the implementation of global initiatives such as the HFA. Comprehensive knowledge of

risks in the field could efficiently and effectively focus efforts needed to avoid vulnerable situations for both society and nature, and even offer concrete solutions to achieve a long-term vision of DRR.

A follow-up on the case study and the combination of methodologies presented in the third chapter is needed to analyze how the dynamics at bottom-up and top-down level continue to work in the long term, given all the externalities in the actual context. More research on methods and application and operationalization examples may contribute to the general knowledge of DRG. Furthermore, publicly available results and a spectrum of possible methods for specific topics may contribute to the empowerment of the local population and the further development of RG mechanisms.

To define the appraisal of the population living in the risk areas, the questions about all kind of risks in the area were given to the population located in flood risk areas. Some of them were also affected by landslides and even droughts, but the majority were focused on floods. The questionnaire was held for six months during 2015. Four years after the disaster events, and being in the second year of a drought event, the perception of the population of the severity of the flood risk may have diminished a great deal.

The interviews were held over several years to obtain continuity and register changes in perceptions of the people working in institutions. Because of the governmental changes, the staff of most public institutions were cut or modified after the impeachment and change of government (2015–2016), making it impossible to find the same people or even the same positions for further interviews. This is the reason why the results present more of a temporal status quo than an analysis of personal change in key actors. At the same time, these changes on their own describe the situation of the region.

Being limited to the deep exploration of only one case study, it is impossible to establish a general definition of how risk governance may be applied at policy level. Nevertheless, by exploring this example, this study defines the tendencies of important elements and actions that should be considered in further research and may be expanded for new case studies.

7.3 Outlook

7.3.1 Implementing the risk governance framework

As the risk governance of the institutions and the population living in risk areas are described in this study, it becomes clear how differences in the management are strongly influenced by the appraisal. Chapter six confirms the importance of management and appraisal linked by communication as the main core in the approach, and chapter three describes the interaction and integration of all the methodologies used to better capture risk governance with quantitative and qualitative data linked to each other in an interdisciplinary approach. Although further exploration of more methodologies for participation and governance is needed, these examples may be a justification and a guide for stakeholders to encourage greater participation mechanisms in regular procedures. Chapters 4 and 5 describe the two sides of the coin. On one side is the low influence of institutions on the local population in comparison to families and friends. On the other side, there is the level of participation of locals in projects, programs, and decisions of the institutions. A lack of trust on both sides is confirmed.

To understand how appraisal is connected to management for all stakeholders, two types of highly contrasting management were identified, the infrastructural and the non-infrastructural (hard and soft implementation measures). How infrastructural management is appraised by all stakeholders greatly defines its importance and the value given to it. Tangible solutions are easy to define, invest in, and see a result, so they are well used by all actors to rate management. On the other hand, the appraisal of other mechanisms such as participation and decision-making differ greatly from institution to institution and is low rated. If more work is required for non-infrastructural solutions, a shift in the appraisal is first needed, prioritizing it on the agenda, budgeting higher amounts for these types of solutions, and understanding its importance.

A follow-up question would be how to implement better communication mechanisms. Communication tools in the area are highly informal. The interviews showed that official web pages and other official sources were little used, or not used at all. This is linked with deeper reasons such as access to technologies and culture. Limited solutions, such as the use of other platforms (like social media) and incentives (payment or benefits for participation), could only be useful temporarily. Communication channels and platforms like social media that reach more of the population must be considered. Face-to-face meetings are still the best platform for discussion and information exchange in two directions, but the limitations of resources, locations, and time have to be considered. Although, in a debate, social media can also be formal and informative, it allows discussion with more flexibility in time and does not require physical spaces or monetary resources.

A complete win-win situation in complex systems is very unlikely. Decision-making in risk governance processes requires actors to deal with trade-offs that need to be understood and considered by all stakeholders. The lack of trust observed between all concerned groups may not be eliminated, but it can be considerably diminished. The population's feeling of neglect in these trade-offs requires an understanding of the complexity and the actors involved in order that they feel acknowledged. Clear communication of how the decisions are made, added to an opportunity to take part in those decisions, should be a key component for better risk governance. Enabling societies to benefit from constant change while avoiding the negative consequences of the associated risks, as the IRGC affirms, requires cohesion of the different stakeholders. Implementing examples like the one presented in the case study on a bigger scale will require significant effort, time, and resource investment.

7.3.2 Towards the continuous improvement of risk governance

In strongly centralized and extremely bureaucratic countries like Brazil, where the gap between institutions and people who may possibly be affected is considerable, the enforcement of stakeholder involvement and insertion of a bottom-up approach is very important. It may not only empower the local population but will also increase resilience and adaptation capacity among organized civil society independent from a constantly changing government. The state of Rio de Janeiro, and especially all peri-urban areas, still have a long way to go with participation and communication measures. More accurate data collection processes, and frequent information and experience exchanges may increase connections and improve communication, increasing the state's capacity for adaptation and setting it as an example for other states and regions. With more environmental and social changes that may bring polarity in a dynamic system, continuity is, and will remain, a real challenge in Brazil. As we saw, continuity and inclusion are key factors in all governance processes, and the strong political changes during the last few years in Brazil seem to push against this continuity. Nevertheless, these abrupt

changes to the top-down system do not affect the organized civil society at the same velocity, and bottom-up inclusive mechanisms seem to be more stable. While the consequences of changes are immediate in respect of public power, (budget cuts, structural changes, and positions shifting), civil society will only shift in the long term at a slower pace. Even with future changes in the government strongly influencing these processes in other directions, networks should grow stronger, skills should grow and governance remain dynamic.

Dynamism and state-of-the-art must be considered. Granting the population access to technology will define communication and working tools, knowledge will determine the translation necessity, and the frequency of the reiteration will be set by resources, participation willingness, and time availability. Changes in tendencies and events, such as the gradual drought in the state, may be an opportunity that could attract the interest of more concerned stakeholders. Future case studies and analysis will require adaptation of the methods. Research should focus on long-term interactions and communication mechanisms between public institutions and civil society to improve knowledge, perception, skills and management. To increase trust, all levels of decision-makers must be considered, considering all their needs (e.g. enough geographical and temporal spaces for information and experience exchange) to increase inclusion of civil society. Participation mechanisms should not be related to only one specific risk but should include various aspects of local interest and gradually give more decision-making power to the population. Furthermore, community organizations that are well established and functioning should be included as existing working platforms.

Wider use of definitions and frameworks like Fung's three dimensions of participation could lead to a better understanding of participation processes and governance. Policymakers should consider and prioritize dynamicity in countries and areas strongly affected by rapid changes and uncertainties. Even with policymakers giving civil society a space for dialogue and a better role in decision-making, it remains a challenge to validate the information and decisions made collectively and apply them continuously. Future work is needed to provide specific information about alternatives to improve knowledge, perception, communication, and stakeholder involvement and apply it in specific cases at all levels to increase adaptation capacity and efficiently reduce risks. To ensure efficiency in results and investment, an equilibrium between the top-down and bottom-up approach needs to be found. Whether or not on the agenda of new governments will decide if resources are given and may put RG mechanisms on a priority list.

8 References

Manandhar S, Pratoomchai W, Ono K, Kazama S, Komori D. Local people's perceptions of climate change and related hazards in mountainous areas of northern Thailand. International Journal of Disaster Risk Reduction 2015;11:47–59.

Adams C, Rodrigues ST, Calmon M, Kumar C. Impacts of large-scale forest restoration on socioeconomic status and local livelihoods: What we know and do not know. Biotropica 2016;48(6):731–44.

Adikari Y, Yoshitani J. Global Trends in Water-Related Disasters: an insight for policymakers: International Centre for Water Hazard and Risk Management ICHARM; 2009.

Aldoory L, Kim J-N, Tindall N. The influence of perceived shared risk in crisis communication: Elaborating the situational theory of publics. Public Relations Review 2010;36(2):134–40.

Ares P, Risler J. Manual de mapeo colectivo: Recursos cartográficos críticos para procesos territoriales de creación colaborativa. Buenos Aires: Tinta Limón; 2013.

Asare-Kyei DK, Kloos J, Renaud FG. Multi-scale participatory indicator development approaches for climate change risk assessment in West Africa. International Journal of Disaster Risk Reduction 2015;11:13–34.

Assmuth T, Hildén M, Benighaus C. Integrated risk assessment and risk governance as socio-political phenomena: a synthetic view of the challenges. Sci. Total Environ. 2010;408(18):3943–53.

Association leader. O trabalho em Corrego Dantas depois da tragédia. Nova Friburgo, 2015.

Aven T. On risk governance deficits. Safety Science 2011;49(6):912–9.

Aylett A. Institutionalizing the urban governance of climate change adaptation: Results of an international survey. Urban Climate 2015;14:4–16.

Barkan SE. Social Change and the Environment: Chapter 20. Maine; 2012.

Becker G, Aerts JCJH, Huitema D. Influence of flood risk perception and other factors on risk-reducing behaviour: A survey of municipalities along the Rhine. J. Flood Risk Manage 2014;7(1):16–30.

BERGER CR, CALABRESE RJ. SOME EXPLORATIONS IN INITIAL INTERACTION AND BEYOND: TOWARD A DEVELOPMENTAL THEORY OF INTERPERSONAL COMMUNICATION. Northwestern Univeristy 1975.

Berkes F. Sacred ecology: Traditional ecological knowledge and resource management. Philadelphia, Pa.: Taylor & Francis; 1999.

Berlo DK. The process of communication: An Introduction to Theory and Practice. New York: Holt, Rinehart and Winston; 1960.

Birkholz S, Muro M, Jeffrey P, Smith HM. Rethinking the relationship between flood risk perception and flood management. Science of The Total Environment 2014;478:12–20.

Birkmann J, editor. Measuring vulnerability to natural hazards: Towards disaster resilient societies. 2nd ed. Tokyo: United Nations Univ. Press; 2013.

Bodoque JM, Amérigo M, Díez-Herrero A, García JA, Cortés B, Ballesteros-Cánovas JA et al. Improvement of resilience of urban areas by integrating social perception in flash-flood risk management. Journal of Hydrology 2016.

Brink E, Aalders T, Ádám D, Feller R, Henselek Y, Hoffmann A et al. Cascades of green: A review of ecosystem-based adaptation in urban areas. Global Environmental Change 2016;36:111–23.

Burch S., Gupta A., Y.A. Inoue C., Kalfagianni A., Persson A., Gerlak A.K, Ishii A., Patterson J., Pickering J., Scobie M., Van der Heijden J, Vervoort J, Adler C, Bloomfield M, Djalante R et al (2019) New directions in earth system governance research, Earth System Governance, Elsevier, January 2019

Burton I. CLIMATE CHANGE AND THE ADAPTION DEFICIT. Climate change building the adaptive capacity 2004.

Bustillos Ardaya A, Evers M, Lars R. Integrated Participatory Methodologies for Disaster Risk Reduction - Tools to analyze complex systems through participatory processes in Brazil. 1st ed.: Springer; 2018.

Bustillos Ardaya A, Evers M, Ribbe L. What influences disaster risk perception?: Intervention measures, flood and landslide risk perception of the population living in flood risk areas in Rio de Janeiro state, Brazil. International Journal of Disaster Risk Reduction 2017.

Bustillos Ardaya A, Evers M, Ribbe L. Participatory approaches for disaster risk governance?: Exploring participatory mechanisms and mapping to close the communication gap between population living in flood risk areas and authorities in Nova Friburgo Municipality, RJ, Brazil. Land Use Policy 2019;88:104103.

Bustillos Ardaya A, Miranda J, Cho M. Global umbrella for local rains: Assessing implementation of the Hyogo Framework for Action in Rio de Janeiro, Brazil. World Water Week Conference 2015;25.

References

Canejo A. Nº de vítimas em tragédia no RJ pode ser 10 vezes maior, dizem entidades, 2015. http://g1.globo.com/rj/regiao-serrana/noticia/2015/08/entidades-apontam-subnotificacao-de-vitimas-da-tragedia-de-2011-na-serra.html (accessed July 22, 2016).

Cardona OD, van Aalst J, Birkmann M, Fordham G, McGregor R, Perez, R.S. RS et al. Determinants of Risk: Exposure and Vulnerability. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA; 2012.

Castells M. Communication power. 2nd ed. Oxford [u.a.]: Oxford University Press; 2013.

CCO - INEA expert. Sistema de aviso temprano. Modo de operação e falhas. Rio de Janeiro, 2014.

Ceccato L, Giannini V, Giupponi C. Participatory assessment of adaptation strategies to flood risk in the Upper Brahmaputra and Danube river basins. Environmental Science & Policy 2011;14(8):1163–74.

Ceddia MG, Christopoulos D, Hernandez Y, Zepharovich E. Assessing adaptive capacity through governance networks: The elaboration of the flood risk management plan in Austria. Environmental Science & Policy 2017;77:140–6.

CEMADEM expert. Defesa Civil, Nova Friburgo. Nova Friburgo, 2014.

Challies E, Newig J, Thaler T, Kochskämper E, Levin-Keitel M. Participatory and collaborative governance for sustainable flood risk management: An emerging research agenda. Environmental Science & Policy 2016;55:275–80.

Chambers R. Participatory rural appraisal (PRA): Challenges, potentials and paradigm. World Development 1994;22(10):1437–54.

Coelho-Netto AL, Avelar AS, Fernandes MC, Lacerda WA. Landslide susceptibility in a mountainous geoecosystem, Tijuca Massif, Rio de Janeiro: The role of morphometric subdivision of the terrain. Geomorphology 2007;87(3):120–31.

Cohen YA. A theory and a model of social change and evolution. Journal of Anthropological Archaeology 1983;2(2):164–207.

Collins AE. Applications of the disaster risk reduction approach to migration influenced by environmental change. Environmental Science & Policy 2013;27:S112-S125.

Collins HM, Evans R. The Third Wave of Science Studies: Studies of Expertise and Experience. Social Studies of Science 2002;32(2):235–96.

Consórcio GITEC / IP/ CODEX REMOTE. CONCEPÇÃO DO ARRANJO INSTITUCIONAL E OPERACIONAL PARA A GESTÃO DE RISCO DE DESASTRES NO ESTADO DO RIO DE JANEIRO: ontrato SEPLAG-RJ no 9/2013 para Serviços de Consultoria; 2014.

Costa SMS, Leite FCL. Brazilian Open Access Initiatives: Key Strategies and Actions. Toronto, Canada: Conference on Electronic Publishing; 2008.

Craig R. Communication Theory as a Field. International communication association 1999;2:119–61.

Custódio A, Corrêa T. Tragédia na Região Serrana teve mais mortos que o divulgado. EXTRA, 2012. http://extra.globo.com/noticias/rio/tragedia-regiao-serrana-2011/tragedia-na-regiao-serrana-teve-mais-mortos-que-divulgado-5685873.html (accessed July 22, 2016).

Daigneault A, Brown P, Gawith D. Dredging versus hedging: Comparing hard infrastructure to ecosystem-based adaptation to flooding. Ecological Economics 2016;122:25–35.

Danzig ER, Thayer PW, Galater LR. The Effects of a Threatening Rumor on a Disease Stricken Community. National Research Council Disaster Study No. 10. Washington, DC; 1958.

de Ven, Andrew H. Van, Aldrich HE. Organizations and Environments. Administrative Science Quarterly 1979;24(2):320.

Dess GG, Beard DW. Dimensions of Organizational Task Environments. Administrative Science Quarterly 1984;29(1):52.

Dobbie MF, Brown RR, Farrelly MA. Risk governance in the water sensitive city: Practitioner perspectives on ownership, management and trust. Environmental Science & Policy 2016;55:218–27.

Dobes L. Getting Real about Adapting to Climate Change: Using 'Real Options' to Address the Uncertainties. Agenda: a journal of policy analisys and reform 2008;15(3):55–69.

Dorasamy M, Raman M, Kaliannan M. Knowledge management systems in support of disasters management: A two decade review. Technological Forecasting and Social Change 2013;80(9):1834–53.

dos R. Pereira D, Martinez MA, Pruski FF, da Silva DD. Hydrological simulation in a basin of typical tropical climate and soil using the SWAT model part I: Calibration and validation tests. Journal of Hydrology: Regional Studies 2016;7:14–37.

Dow K, Cutter SL. Crying wolf: Repeat responses to hurricane evacuation orders. Coastal Management 1998;26(4):237–52.

Doyle EEH, McClure J, Paton D, Johnston DM. Uncertainty and decision making: Volcanic crisis scenarios. International Journal of Disaster Risk Reduction 2014;10:75–101.

DRM expert. O trabalho de DRM na redução de riscos. Rio de Janeiro, 2015.

Dubois O. Capacity to manage role changes in forestry: Introducing the 4R's framework. iied 1998.

Dubrow JK. Political Inequality in the Age of Democracy: Cross-national Perspectives: Routledge Taylor & Francis Group; 2015.

Eden C. ON THE NATURE OF COGNITIVE MAPS. Journal of Management Studies 1992;29(3):261–5.

Education Worldwide. Bildungsforschung in Brasilien, 2013. http://www.education-worldwide.de/Educational-Research-in-Brazil-7007_e.html (accessed June 03, 2015).

Eranıl Demirli M, Tuna Ultav Z, Demirtaş-Milz N. A socio-spatial analysis of urban transformation at a neighborhood scale: The case of the relocation of Kadifekale inhabitants to TOKİ Uzundere in İzmir. Cities 2015;48:140–59.

Evers M, Jonoski A, Almoradie A, Lange L. Collaborative decision making in sustainable flood risk management: A socio-technical approach and tools for participatory governance. Environmental Science & Policy 2016;55:335–44.

Federal government of Brazil. Plano Nacional de Gestão de Riscos e Resposta a Desastres Naturais. Brasilien; 2012.

Fekete A. Safety and security target levels: Opportunities and challenges for risk management and risk communication. International Journal of Disaster Risk Reduction 2012;2:67–76.

Ferreira LC. "Pior enchente" do Rio de Janeiro completa 50 anos, 2016. http://www.ebc.com.br/noticias/meio-ambiente/2015/12/pior-enchente-do-rio-de-janeiro-completa-50-anos (accessed September 28, 2016).

Fontana A, Frey J. Interviewing The Art of Science; 1994.

GGCA. Gender and disaster risk reduction: Gender ans Climate Change with the United Nation Development Program; 2013.

Gibson CC, Ostrom E, Ahn TK. The concept of scale and the human dimensions of global change: a survey. Ecological Economics 2000a;32:217–39.

Gibson CC, Ostrom E, Ahn TK. The concept of scale and the human dimensions of global change: a survey. Ecological Economics 2000b;32(2):217–39.

GITEC / IP/ CODEX REMOTE. Concepção do arranjo Institucional e operacional para a gestão de risco de desastres no estado do Rio de Janeiro; 2013.

Gouldson A, Morton A, Pollard SJT. Better environmental regulation--contributions from risk-based decision-making. The Science of the total environment 2009;407(19):5283–8.

Grimble R. Stakeholder Methodologies in natural resource management: Socioeconomic Methodologies. Natural Resources Institute 1998.

GRJ. Portal Transparencia: Orçamento Fácil, 2015. http://www.transparencia.rj.gov.br/transparencia/faces/OrcamentoTematico/orcamentoFacil?_afrLoop=1262380790100000&_afrWindowMode=0&_adf.ctrl-state=mb81pcofu_24 (accessed June 03, 2015).

Guha-Sapir D, Below R, Hoyois P. EM-DAT: The CRED/OFDA International Disaster Database, 2015. http://www.emdat.be/database (accessed September 28, 2016).

Hamarat C, Kwakkel JH, Pruyt E, Loonen ET. An exploratory approach for adaptive policymaking by using multi-objective robust optimization. Simulation Modelling Practice and Theory 2014;46:25–39.

Heath RL. Management of corporate communication: From interpersonal contacts to external affairs. Hillsdale, N.J: Erlbaum; 1994.

Henriksen HJ, Roberts MJ, van der Keur P, Harjanne A, Egilson D, Alfonso L. Participatory early warning and monitoring systems: A Nordic framework for web-based flood risk management. International Journal of Disaster Risk Reduction 2018;31:1295–306.

Herbert SA. JSTOR: Biometrika, Vol. 42, No. 3/4 (Dec., 1955), pp. 425-440, 1955. http://www.jstor.org/discover/10.2307/2333389?sid=21105504054231&uid=4&uid=2&uid=3737864 (accessed March 02, 2015).

Hiwasaki L, Luna E, Syamsidik, Shaw R. Process for integrating local and indigenous knowledge with science for hydro-meteorological disaster risk reduction and climate change adaptation in coastal and small island communities. International Journal of Disaster Risk Reduction 2014;10:15–27.

Horita FE, Albuquerque JP. An Approach to Support Decision-Making in Disaster Management based on Volunteer Geographic Information (VGI) and Spatial Decision Support Systems (SDSS). Supporting Disaster Management using VGI and SDSS 2013.

IBGE. Tendências demográficas: Uma análise dos resultados da sinopse preliminar do censo demográfico 2000. Rio de Janeiro: IBGE; 2001.

IBGE. Banco de dados socioeconomicos, 2010.

IBGE. Estadistica dos estados, 2017. http://www.ibge.gov.br/estadosat/perfil.php?sigla=rj (accessed January 16, 2017).

INCID. Cadernos Municipais dos Indicadores de Cidadania Nova Friburgo; 2015.

INCID expert. Cidadania ativa na redução de riscos. Nova Friburgo, 2015.

INCID expert. Desnaturalizacao dos desastres no estado de RJ. Brasília, 2016.

INEA. Flood alert system, 2015. undefined (accessed June 03, 2015).

INEA expert. Functioning of the INEA alert system. Rio de Janeiro, 2015a.

References

INEA expert. O trabalho da INEA em redução de riscos. Rio de Janeiro, 2015b.

IPCC. Managing the risks of extreme events and disasters to advance climate change adaptation: Special report of the Intergovernmental Panel on Climate Change. Geneva: IPCC; 2012.

IPCCC. Water and climate change impacts and adaptation strategies: Technical paper; 2011.

IRGC. Risk Governance: Towards an integrative approach. Geneva; 2005.

IRGC. Risk governance deficits: An analysis and illustration of the most common deficits in risk governance. Geneva: IRGC International Risk Governance Council; 2009.

IRGC. An_introduction_to_the_IRGC_Risk_Governance_Framework; 2010a.

IRGC. Risk governance deficits: Analysis, illustration and recommendations. Geneva: International Risk Governance Council; 2010b.

IRGC. Public Sector Governance of Emerging Risks: Hallmarks and drivers. Workshop report; 2013.

IRGC. Core Concepts, 2018. https://irgc.org/publications/core-concepts-of-risk-governance/ (accessed November 15, 2019).

ISDR. Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters, 2005. http://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf.

Johnson N, Lilja N, Ashby JA, Garcia JA. The practice of participatory research and gender analysis in natural resource management. Natural Resources Forum 2004;28(3):189–200.

Kalame FB, Aidoo R, Nkem J, Ajayie OC, Kanninen M, Luukkanen O et al. Modified taungya system in Ghana: A win–win practice for forestry and adaptation to climate change? Environmental Science & Policy 2011;14(5):519–30.

Kangas A, Laukkanen S, Kangas J. Social choice theory and its applications in sustainable forest management—a review. Forest Policy and Economics 2006;9(1):77–92.

Kapucu N, Garayev V. Collaborative Decision-Making in Emergency and Disaster Management. International Journal of Public Administration 2011;34(6):366–75.

Kellens W, Terpstra T, Maeyer P de. Perception and Communication of Flood Risks: A Systematic Review of Empirical Research. Risk Analysis 2013;33(1):24–49.

King D, Bird D, Haynes K, Boon H, Cottrell A, Millar J et al. Voluntary relocation as an adaptation strategy to extreme weather events. International Journal of Disaster Risk Reduction 2014;8:83–90.

Klaiman T, Knorr D, Fitzgerald S, DeMara P, Thomas C, Heake G et al. Locating and communicating with at-risk populations about emergency preparedness: the vulnerable populations outreach model. Disaster Med Public Health Prep 2010;4(3):246–51.

Klinke A, Renn O. Adaptive and integrative governance on risk and uncertainty. Journal of Risk Research 2012;15(3):273–92.

Kwakkel JH, Walker WE, Marchau VAWJ. Adaptive Airport Strategic Planning. EJTIR 2010;3(10):249–73.

Lasswell HD. The structure and function of communication in society. The Institute for Religious and Social Studies 1948:215–28.

Lawrence J, Reisinger A, Mullan B, Jackson B. Exploring climate change uncertainties to support adaptive management of changing flood-risk. Environmental Science & Policy 2013;33:133–42.

Lempert RJ, Collins MT. Managing the risk of uncertain threshold responses: comparison of robust, optimum, and precautionary approaches. Risk Anal. 2007;27(4):1009–26.

Leskens JG, Brugnach M, Hoekstra AY, Schuurmans W. Why are decisions in flood disaster management so poorly supported by information from flood models? Environmental Modelling & Software 2014;53:53–61.

Lin S, Shaw D, Ho M-C. Why are flood and landslide victims less willing to take mitigation measures than the public? Nat Hazards 2008;44(2):305–14.

Lindell MK, Perry RW. Communicating environmental risk in multiethnic communities. California: Sage publications Ltd; 2004a.

Lindell MK, Perry RW. Communicating environmental risk in multiethnic communities. Thousand Oaks, Calif: Sage; 2004b.

Lopez T de, Elliott M, Armstrong A, Lobuglio J, Bartram J. Technologies for climate change adaptation. The water sector; 2011.

Marengo JA. O futuro clima do Brasil. Rev. USP 2014(103):25.

Mashi SA, Obaro O, Inakani AI. Disaster risks and management policies and practices in Nigeria: A critical appraisal of the National Emergency Management Agency Act. International Journal of Disaster Risk Reduction 2018.

Mauelshagen C, Smith M, Schiller F, Denyer D, Rocks S, Pollard S. Effective risk governance for environmental policy making: A knowledge management perspective. Environmental Science & Policy 2014;41:23–32.

Mayhorn CB, Collins McLaughlin A. Warning the world of extreme events: A global perspective on risk communication for natural and technological disaster. Safety Science 2014;61:43–50.

McGurk B, Sinclair J, Diduck A. An Assessment of Stakeholder Advisory Committees in Forest Management: Case Studies from Manitoba, Canada 2006:809–26.

Mees H, Alexander M, Gralepois M, Matczak P, Mees H. Typologies of citizen co-production in flood risk governance. Environmental Science & Policy 2018;89:330–9.

Metlay D. Institutional Trust and Confidence: A Journey into a Conceptual Quagmire. Social Trust and the Managemant of Risk 1999:100–16.

Mileti DS, Peek L. The social psychology of public response to warnings of a nuclear power plant accident. Journal of Hazardous Materials 2000;75:181–94.

Ministério da Educação. Catálogo de Teses & Dissertações - CAPES, 2018. http://catalogodeteses.capes.gov.br/catalogo-teses/#!/ (accessed June 30, 2018).

Mitchell D, Enemark S, van der Molen P. Climate resilient urban development: Why responsible land governance is important. Land Use Policy 2015;48:190–8.

Moreira F, Fontes I, Dias S, Silva JBe, Loupa-Ramos I. Contrasting static versus dynamic-based typologies of land cover patterns in the Lisbon metropolitan area: Towards a better understanding of peri-urban areas. Applied Geography 2016;75:49–59.

Morss RE, Mulder KJ, Lazo JK, Demuth JL. How do people perceive, understand, and anticipate responding to flash flood risks and warnings?: Results from a public survey in Boulder, Colorado, USA. Journal of Hydrology 2015.

Müller-Mahn H-D. The spatial dimension of risk: How geography shapes the emergence of riskscapes. London: New York; Routledge; 2013.

Munene MB, Swartling ÅG, Thomalla F. Adaptive governance as a catalyst for transforming the relationship between development and disaster risk through the Sendai Framework? International Journal of Disaster Risk Reduction 2018;28:653–63.

Munich Re. Worst natural disasters statistics | Munich Re, 2016. https://www.munichre.com/en/reinsurance/business/non-life/natcatservice/significant-natural-catastrophes/index.html (accessed September 28, 2016).

Munich Re. NatCatSERVICE analysis tool, 2018. https://natcatservice.munichre.com/events/1?filter=eyJ5ZWFyRnJvbSI6MTk4OCwieWVhclRvIjoyMDE4fQ%3D%3D&type=1 (accessed April 19, 2019).

Nakmofa Y, Lassa J. Community Based Approach to Disaster Risk Reduction and Climate Change Adaptation Towards Sustainable Livelihood: Ten Years Experiences From PMPB Kupang. Journal of Ntt Studies 2009;1(2):136–45.

Nehren U, Schlüter S, Raedig C, Sattler D, Hissa H. Strategies and tools for a sustainable rural Rio de Janeiro. Cham, Switzerland: Springer; 2019.

Netto ALC, Sato AM, Souza Avelar A de, Vianna LGG, Araújo IS, Ferreira DLC et al. January 2011: The Extreme Landslide Disaster in Brazil. In: Margottini C, Canuti P, Sassa K, editors. Landslide Science and Practice: Volume 6: Risk Assessment, Management and Mitigation. Dordrecht: Springer; 2013. p. 377–384.

Neufville Rd. Dynamic strategic planning for technology policy. IJTM 2000;19(3/4/5):225.

OECD. OECD Global Science Forum: Applications unanticipated consequences and unrealized opportunities. Paris; 2009.

OECD. Boosting resilience through innovative risk governance. Paris: OECD; 2014.

OECD. Boosting disaster prevention through innovative risk governance: Insights from Austria, France and Switzerland. Paris, Paris: OECD Publishing; 2017.

Ostrom E. Frameworks and theories of environmental change. Global Environmental Change 2008;18(2):249–52.

Pachauri RK, Mayer L, editors. Climate change 2014: Synthesis report. Geneva, Switzerland: Intergovernmental Panel on Climate Change; 2015.

Palenchar MJ, Heath RL. Strategic risk communication: Adding value to society. Public Relations Review 2007;33(2):120–9.

Parsons M, Glavac S, Hastings P, Marshall G, McGregor J, McNeill J et al. Top-down assessment of disaster resilience: A conceptual framework using coping and adaptive capacities. International Journal of Disaster Risk Reduction 2016;19:1–11.

Pasini A, Mazzocchi F. A multi-approach strategy in climate attribution studies: Is it possible to apply a robustness framework? Environmental Science & Policy 2015;50(0):191–9.

Pelling M. What determines vulnerability to floods; a case study in Georgetown, Guyana. Environment and Urbanization 1997;9(1):203–26.

Pereira, Eder Johnson de Area L, Silveira Ferreira, Pualo J, de Santana Ribeiro Luis C, Carvalho,Hernane, Terciane S, Borges de Barros Pereira (2019) Policy in Brazil (2016–2019) threaten conservation of the Amazon rainforest, Environmental Science & Policy, Elsevier

Pereira E. Johnson de Area L, de Santana Ribeiro Luiz C, da Silva Freitas Lucio F., Borges de Barros Pereira H (2020) Brazilian policy and agribusiness damage the Amazon rainforest Land Use Policy, Elsevier

References

Pickering C, Grignon J, Steven R, Guitart D, Byrne J. Publishing not perishing: How research students transition from novice to knowledgeable using systematic quantitative literature reviews. Studies in Higher Education 2015:1–14.

Pielke RA, Adegoke J, Niyogi D, Kallos G, Seastedt TR, Hossain F. Climate vulnerability: Understanding and addressing threats to essential resources. VOL5. VULNERABILITY OF WATER RESOURCES TO CLIMATE. Amsterdam: Elsevier Academic Press; 2013.

Prasetio EA, Arifianti Y, Hardjakaprabon B, Agustin F. Triple Helix in Disaster Management: Case Study of Strategic Environmental Assessment (SEA) for Government Office Relocation Planning of Padang City, Indonesia. Procedia - Social and Behavioral Sciences 2012;52:150–9.

Rasmus Kløcker Larsen, Åsa Gerger Swartling, Neil Powell, Brad May, Ryan Plummer, Louise Simonsson et al. A framework for facilitating dialogue between policy planners and local climate change adaptation professionals: Cases from Sweden, Canada and Indonesia.

Reed MS, Graves A, Dandy N, Posthumus H, Hubacek K, Morris J et al. Who's in and why? A typology of stakeholder analysis methods for natural resource management. Journal of environmental management 2009;90(5):1933–49.

Reid WV. Ecosystems and human well-being: Synthesis ; a report of the Millennium Ecosystem Assessment. Washington, DC: Island Press; 2005.

Renn O. Concepts of risk: A classification: In Krimsky, Sheldon (Hrsg.): Social theories of risk. Westport, Conn: Praeger; 1992.

Renn O, Burns WJ, Kasperson JX, Kasperson RE, Slovic P. The Social Amplification of Risk: Theoretical Foundations and Empirical Applications. Journal of Social Issues 1992;48(4):137–60.

Renn O, Klinke A, van Asselt M. Coping with Complexity, Uncertainty and Ambiguity in Risk Governance: A Synthesis. AMBIO 2011;40(2):231–46.

Renn O, Walker KD. Global risk governance: Concept and practice using the IRGC framework. Dordrecht, the Netherlands: Springer; 2008a.

Renn O, Walker KD, editors. Global Risk Governance. Dordrecht: Springer Netherlands; 2008b.

Rice M., Henderson-sellers A. (2012): Chapter 18 Future Climate One Vital Component of Trans-disciplinary Earth System Science: Elsevier (Book series The Future of the World's Climate)

Rothstein HF. Precautionary Bans or Sacrificial Lambs? Participative Risk Regulation and the Reform of the UK Food Safety Regime. Public Administration 2004;82(4):857–81.

Rousseau DM, Sitkin SB, Burt RS, Camerer C. NOT SO DIFFERENT AFTER ALL: A CROSS-DISCIPLINE VIEW OF TRUST. Academy of Management Review 1998;23:393–404.

Rowe G, Wright G. Differences in Expert and Lay Judgments of Risk: Myth or Reality? Risk Analysis 2001;21(2):341–56.

Rowley J. The wisdom hierarchy: Representations of the DIKW hierarchy. Journal of Information Science 2007;33(2):163–80.

Royal Society Study Group on Risk Assessment. Risk: analysis, perception, measurement. London: Royal Society; 1992.

Ruiz-Rivera N, Melgarejo-Rodríguez CR. Political inequality and local government capacity for Disaster Risk Reduction: Evidence from Mexico. International Journal of Disaster Risk Reduction 2017;24:38–45.

Schelfaut K, Pannemans B, van der Craats I, Krywkow J, Mysiak J, Cools J. Bringing flood resilience into practice: The FREEMAN project. Environmental Science & Policy 2011;14(7):825–33.

Schensul JJ. Focused Group Interviews. Enhanced Ethnographic Methods; 2013.

Schewe Jacob, Heinke Jens, Gerten, Dieter; Haddeland, Ingjerd; Arnell, Nigel; Clark, Douglas; Dankers, Rutger; Eisner, Stephanie; Fekete, Balázs; Kim, H.; Liu, X.; Masaki, Y.; Portmann, F.; Satoh, Y.; Stacke, T.; Tang, Q.; Wada, Y.; Wisser, D.; Albrecht, T. (2013) How climate change will exacerbate global water scarcity, EGU General Assembly 2013, held 7-12 April, 2013 in Vienna, Austria, id. EGU2013-11770

Schipper L, Burton I. The Earthscan reader on adaptation to climate change. London, Sterling, Va.: Earthscan; 2009.

Schramm W. How communication works. In W. Schramm (Ed.), The process and effects of communication. Urbana, Illinois: University of Illinois Press 1954:3–26.

Schumann A. Flood risk assessment and management: How to specify hydrological loads, their consequences and uncertainties. Berlin, Heidelberg, New York: Springer; 2011.

Schweizer and Renn 2019 (PDF) Governance of Systemic Risks for Disaster Prevention and Mitigation. Available from: https://www.researchgate.net/publication/335339691_Governance_of_Systemic_Risks_for_Disaster_Prevention_and_Mitigation [accessed May 12 2020].

Scolobig A, Prior T, Schröter D, Jörin J, Patt A. Towards people-centred approaches for effective disaster risk management: Balancing rhetoric with reality. International Journal of Disaster Risk Reduction 2015;12:202–12.

Scott M, White I, Kuhlicke C, Steinführer A, Sultana P, Thompson P et al. Living with flood risk/The more we know, the more we know we don't know: Reflections on a decade of planning, flood risk management and false precision/Searching for resilience or building social capacities for flood risks?/Participatory floodplain management: Lessons from Bangladesh/Planning and retrofitting for floods: Insights from Australia/Neighbourhood design considerations in flood

risk management/Flood risk management – Challenges to the effective implementation of a paradigm shift. Planning Theory & Practice 2013;14(1):103–40.

Seyranian V. Social identity framing communication strategies for mobilizing social change. The Leadership Quarterly 2014;25(3):468–86.

Shannon CE, Weaver W. The mathematical theory of communication. Urbana: University of Illinois Press; 1964 [©1949.

Siegrist M, Gutscher H. Flooding risks: a comparison of lay people's perceptions and expert's assessments in Switzerland. Risk analysis an official publication of the Society for Risk Analysis 2006;26(4):971–9.

Slovic P. Perception of Risk. Science 236 1987:280285.

Smith W, Dowell J. A case study of co-ordinative decision-making in disaster management. Ergonomics 2000;43(8):1153–66.

SMMADUS. Meio Ambiente Digital Nova Friburgo: Secretaria Municipal do Meio Ambiente e Desenvolvimento Urbano Sustentável, 2016. https://meioambientedigital.pmnf.rj.gov.br/ (accessed July 18, 2016).

Soares Macedo I. Revisão do Plano Diretor de Nova Friburgo 2014, 2014. http://www.planodiretornf2014.org/ (accessed February 23, 2016).

Sohi RS. The effects of environmental dynamism and heterogeneity on salespeople's role perceptions, performance and job satisfaction. European Journal of Marketing 1996;30(7):49–67.

Steelman TA, Maguire LA. Understanding participant perspectives: Q-methodology in national forest management. J. Pol. Anal. Manage. 1999;18(3):361–88.

Steffen WL, Eliott S. Global change and the earth system: A planet under pressure executive summary. Stockholm, Sweden: IGBP Secretariat; 2004.

Stern PC, Fineberg HV. Understanding risk: Informing decisions in a democratic society. Washington, D.C.: National Academy Press; 1996.

Strassburg BBN, Barros FSM, Crouzeilles R, Iribarrem A, Santos JSd, Silva D et al. The role of natural regeneration to ecosystem services provision and habitat availability: A case study in the Brazilian Atlantic Forest. Biotropica 2016;48(6):890–9.

Taylor-Powell E. Program Development and Evaluation: Questionnaire Design: Asking Questions with a Purpose; 1998.

The Economist. Go south, young scientist, 2011. http://www.economist.com/node/17851421 (accessed June 03, 2015).

Tian L, Ge B, Li Y. Impacts of state-led and bottom-up urbanization on land use change in the peri-urban areas of Shanghai: Planned growth or uncontrolled sprawl? Cities 2016.

Trias AP, Lassa J, Surjan A. Connecting the actors, discovering the ties: Exploring disaster risk governance network in Asia and the Pacific. International Journal of Disaster Risk Reduction 2018.

Turchin P, Grinin LE, Korotaev AV, Munck VCd. History and Mathematics: Historical dynamics and development of complex societies / Edited by Peter Turchin, Leonid Grinin, Andrey Korotaev, Victor C. de Munck. Moskva: URSS; 2006.

Ulrich H, Probst G. Anleitung zum ganzheitlichen Denken und Handeln: Ein Brevier für Führungskräfte. 3rd ed. Bern: Haupt; 1995.

UNDRR. Sendai Framework for Disaster Risk Reduction 2015 - 2030: United Nations Office for Disaster Risk Reduction; 2015.

UNISDR. Global Assessment Report on Disaster Risk Reduction: Making development sustainable. The future of disaster risk management. Geneva: United Nations; 2015a.

UNISDR. Prepared for the 2015 Global Assessment Report on Disaster Risk Reduction: DISASTER RISK REDUCTION IS AN INTEGRAL OBJECTIVE OF ENVIRONMENT RELATED POLICIES AND PLANS, INCLUDING FOR LAND USE, NATURAL RESOURCE MANAGEMENT AND ADAPTATION TO CLIMATE CHANGE; 2015b.

Universidade Federal de Santa Catarina. Capacitação Basica em Defesa Civil 2012 (accessed September 23, 2016). http://www.mi.gov.br/documents/10157/402604/Capacita%C3%A7%C3%A3o+B%C3%A1sica+em+Defesa+Civil+-+Livro+do+curso+em+Ambiente+Virtual+de+Ensino-Aprendizagem+-+2+Edi%C3%A7%C3%A3o.pdf/64ae64bb-c9a8-4287-b194-bec93fea3049?version=1.0.

van Asselt MBA. The complex significance of uncertainty in a risk era: logics manners and strategies in use. Int. Risk Assessment and Management 2005;5(2/3/4):125–58.

Viva Rio. Viva Rio lança projeto na Região Serrana, 2016. http://vivario.org.br/ (accessed July 18, 2016).

Wagner K. Mental models of flash floods and landslides. Risk analysis an official publication of the Society for Risk Analysis 2007;27(3):671–82.

Walker WE, Haasnoot M, Kwakkel JH. Adapt or perish: a review of planning approaches for adaptation under deep uncertainty. Sustainability 2013;5:955–79.

Walonick DS. Survival statistics. Minneapolis, Minn.: StatPac; 2003.

Wamsler C. Stakeholder involvement in strategic adaptation planning: Transdisciplinarity and co-production at stake? Environmental Science & Policy 2017;75:148–57.

References

Webster D. On the Edge: Shaping the Future of Peri-urban East Asia; 2002.

White GF, Robert KW, Burton I. Knowing better and losing even more: the use ofknowledge in hazards management. Environmental Hazards 2001;3:81–92.

Wijbenga FH, van Witteloostuijn A. Entrepreneurial locus of control and competitive strategies – The moderating effect of environmental dynamism. Journal of Economic Psychology 2007;28(5):566–89.

World Bank. Avaliação de Perdas e Danos: Inundações e Deslizamentos na Região Serrana do Rio de Janeiro - Janeiro de 2011; 2012.

Wright JD. International encyclopedia of the social & behavioral sciences. Amsterdam: Elsevier; 2015.

Zuo W, Zhu W, Wang F, Wei J, Bondar A. Exploring the institutional determinants of risk governance: A comparative approach across nations. International Journal of Disaster Risk Reduction 2017;24:135–43.

9 Annexes

9.1 Method Article

Method for participatory mapping
Keywords: participatory mapping, GIS, analog to digital

ABSTRACT
Here we describe a methodology for participatory mapping adapted for risk mapping and improved to be later digitalized. Above the whole participatory process as an opportunity for discussion and dialog among the participants, it was important for us to be able to digitalize the information obtained and geo-reference it for further calculations and comparisons. We used an existing methodology for participatory mapping developed for Latin America and added some elements to make results geographically accurate, measurable and comparable.

- Instead of a blank sheet, we start on a simplified map where actual location of roads, rivers and housing are present.
- The elements, tokens, lines and areas to be marked are adapted to risk mapping.
- The outcomes of the process are the participatory maps in paper and in digital. The digital version can be constantly updated, and all possibilities of GIS calculations are open.

When to use it?
This methodology was adapted to be used in environments where computers are not an option. Whether if it is because of lack of resources, electricity or other technologies in the area, this methodology allows the use of papers and markers and the later digitalization. The outputs can be digitalized in a trustable way, making it easy to use for measurements, comparison and geo referencing.

This specific case was adapted for participatory risk mapping, but the possibilities are much bigger according to the specific objectives (see references). You do need to prepare some material before going to the field; print the base maps (finding a plotter to print A0 size papers might be the most difficult task) and the tokens, bring markers, pens, strings, tape and additional paper.

How to use it?
Participatory maps require simplified satellite pictures of the neighborhoods printed in big sheets of paper (e.g. A0) where only roads, houses, and river paths are visible as simple lines and polygons (Fig1). Google maps has already roads and rivers marked, simplifying the extraction of houses from the picture. The scale may differ according to requirements, since we needed to recognize houses and streets on the maps, we had scales from 1:9000 to 1:1000. Different from other suggested methods for participatory mappings that start on blank sheets, these elements simplify location and digitization processes, making them geographically accurate.

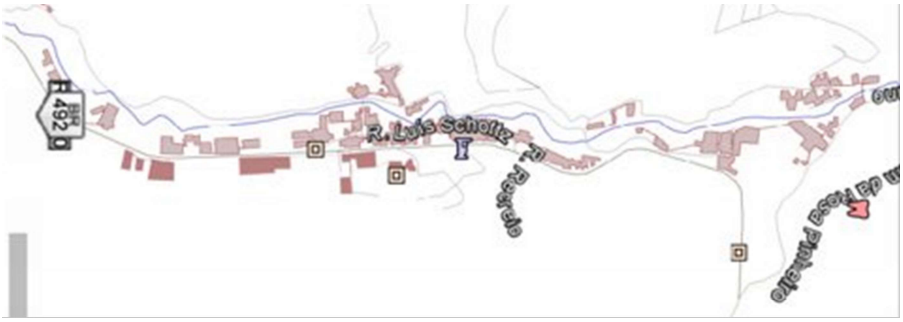


Figure 9.1. Blank map for the discussion (houses, river, and roads for location)

Also important is the creation of tokens or small pieces of papers that will allow the location of elements of interest. We printed symbols for physical references as crops, springs, churches, schools or hospitals and for locations that were opened to discussion like evacuation points, risk areas like landslides, droughts, water contamination, loss of springs, and manipulation of the river or even possible strategic location for bridges and other infrastructure. Using paper color for the tokens helps to differentiate already given locations from discussion points.

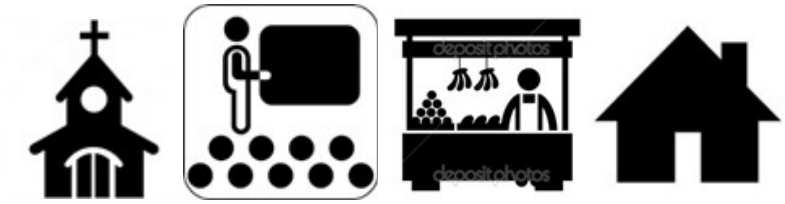


Figure 9.2. Example for the tokens for specific locations (church, school, market, and specific houses)

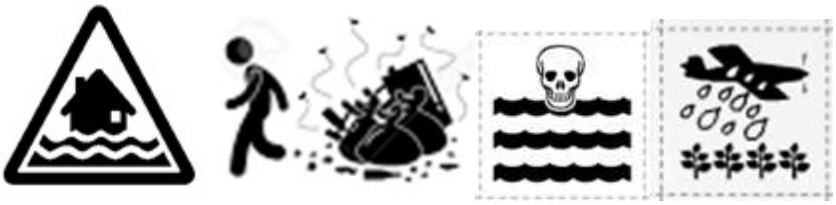


Figure 9.3. Example for the tokens opened to discussion (flood, waste, chemicals in water and agrochemicals)

During the exercise existing elements, are first located to familiarize with e map. Houses of the participants and infrastructure. Later, problems in the area, are discussed and marked with the illustrated labels. After discussion, they can be moved and help clarification. Labels or tokens simplify the process and encourage involvement: drawing or writing on the maps requires extra skills that not all participants have.

Figure 9.4. Discussion during the participatory mapping activity

For lines or areas, the use of strings or thread is recommended, also to be able to move it during discussion. Maximum water level experienced in floods and normal overflow are delineated together with evacuation routes and possible shelters. Discussion is encouraged as a promoter of involvement, information, and perception sharing in the group. Additionally, this process organizes personal ideas, shapes them collectively, and creates a final product to be shared.

Figure 9.5. Map after the location of points, lines and areas.

Since houses rivers and road references are geographically accurate, maps can be later digitalized with the help of open programs like QGIS. Georeferenced maps and shapefiles produced allow calculation of areas and distances, joining maps created in different areas or with different groups and compare them. For this case we

compared the differences in the flood area according to the different maps and correlate them with distances to shelters, hospitals and evacuation points.

Figure 9.6. Digital map based on the participatory approach

The digital maps are available online for validation and further uses and the calculations were a rich input for the publication. Other information as possible locations for future infrastructure could be an input for public institutions working on development plans of the area. Not only necessity for infrastructure, working groups and networks were mapped, but they were also prioritized according to the perception of the present group

***References:**

Ares, P. and Risler, J.: Manual de mapeo colectivo: Recursos cartográficos críticos para procesos territoriales de creación colaborativa, Tinta Limón, Buenos Aires, 80 pp., 2013.

9.2 Survey

Redução de Riscos

O projeto INTECRAL faz parte do Ministério da Educação e Pesquisa (BMBF) e Secretaria do Estado da Agricultura e Pecuária do Projeto Rio Rural (SEAPEC-PRR). Este estudo sobre a redução do risco de desastres é feito na bacia do Rio Dois Rios. O questionário destina-se a melhorar a competitividade do setor econômico rural, levando em consideração uma gestão sustentável das bacias hidrográficas, incluindo a mitigação do risco ambiental e proteção dos recursos naturais. Dentro do projeto, vamos avaliar a gestão dos riscos de inundação e deslizamentos de terra na região da bacia Rio Dois Rios (Nova Friburgo e São Fidéis) para obter uma melhor proteção para os habitantes.

* Required

1. **CODIGO DA ENCUESTA (e. RG02001)**
   Escreva só as iniciais do seu municipio (BJ para bom jardim) e suas iniciais

2. **Favor escreba suas coordenadas decimais: LONGITUD (e. -42,530000)**
   Pode procurar sua casa no mapa de Google maps https://www.google.de/maps/@-22.1435325,-42.5691461,11.25z, fazendo click no ponto desejado, as coordenadas aparecerão.

3. **Favor escreba suas coordenadas decimais: LATITUD (e. -22,280000)**
   Pode procurar sua casa no mapa de Google maps https://www.google.de/maps/@-22.1435325,-42.5691461,11.25z, fazendo click no ponto desejado, as coordenadas aparecerão.

4. **Altura em metros (e. 788)**

5. **Endereço**
   Caso não ter encontrado suas coordenadas, favor escrever o endereço o mais exato possivel

6. **1.Qual é o seu sexo?** *
   Mark only one oval.
   ◯ Feminino ◯ Masculino

7. **2. Idade (anos)** *

_____

8. **3. Há quanto tempo você mora na área? (anos)** *

_____

9. **4. Qual dos seguintes serviços você tem em casa?**
Marque um ou mais itens
Check all that apply.

- [ ] TV
- [ ] Internet
- [ ] Rádio
- [ ] Telefone
- [ ] Celular

10. **4. Quantas pessoas moram em casa?**

_____

11. **5. Setor de trabalho**
Check all that apply.

- [ ] Agrícola/pecuario
- [ ] Industrial
- [ ] Comercial
- [ ] Governamental
- [ ] Aposentada/o
- [ ] Desempregado/a
- [ ] Other: _____

12. **6. Qual das áreas abaixo você acha que deveria ser a prioridade das instituições na sua cidade?**
Check all that apply.

- [ ] Saneamento
- [ ] Inundações e deslizamentos
- [ ] Mapeamento
- [ ] Infraestrutura
- [ ] Other: _____

Do

13. **7. Você acha que sua casa está em perigo por causa dos deslizamentos de terra?**
Mark only one oval.

	1	2	3	4	
Não tem perigo	◯	◯	◯	◯	Muito perigo

14. **Razões do perigo**

_____

15. **Você acha que sua casa está em perigo por causa das inundações?**
Mark only one oval.

	1	2	3	4	
Não tem perigo	◯	◯	◯	◯	Muito perigo

16. **Razões do perigo inundacoes**

_____

17. **8. No caso de ter perigo, você pretende mudar de residência?**
Mark only one oval.

- ◯ Assim que eu encontrar outra
- ◯ Não sei
- ◯ Não tenho os recursos
- ◯ Não preciso
- ◯ Já mudei (Terra Nova u otros)
- ◯ Other: _____

18. **9. Nos últimos anos, as inundações e deslizamentos vem ocorrendo com frequência. Você já vivenciou inundações ou deslizamentos de terra?**
Mark only one oval.

- ◯ Inundações *Skip to question 19.*
- ◯ Deslizamentos de terra *Skip to question 19.*
- ◯ Inundações e Deslizamentos *Skip to question 19.*
- ◯ Seca *Skip to question 19.*
- ◯ Nenhum *Skip to question 28.*

Experiências anteriores

19. **Quando foi a última inundação /deslizamento (Mês / Ano)?**

_____
Example: December 15, 2012

20. **Lembra de alguma antes?**
Se não lembrar o mes o a data pode deixar em 01.Janeiro

_____

Example: December 15, 2012

21. **10. Você foi informado sobre o evento com antecedência?**
Mark only one oval.

- ◯ Sim
- ◯ Não

22. **Como você foi informado da inundação ou do deslizamento? (Marque um ou mais itens)**
Check all that apply.

- ☐ Observação direta
- ☐ Parentes ou amigos
- ☐ Radio, TV
- ☐ Telefone/SMS
- ☐ Sirene/ Alarme
- ☐ Defesa Civil, Bombeiros
- ☐ Other: _____

23. **11. Você precisou tomar alguma medida por causa dessa inundação /deslizamento?**
Mark only one oval.

- ◯ Evacuação
- ◯ Medidas de contenção
- ◯ Contenção e evacuação
- ◯ Nenhuma
- ◯ Other: _____

24. **12. Você recebeu ajuda para a evacuação, as medidas de contenção u otros durante o evento?**
Mark only one oval.

- ◯ Sim, dos bombeiros
- ◯ Sim, da Defesa Civil
- ◯ Sim, de parentes e amigos
- ◯ Nenhuma
- ◯ Other: _____

25. **13. Você recebeu ajuda econômica depois do evento?**
Check all that apply.

- [ ] Sim, da assistência social
- [ ] Sim, da Defesa Civil
- [ ] Sim, de parentes e amigos
- [ ] Sim, do governo federal/estadual
- [ ] Nenhuma
- [ ] Other: _____

26. **Se sim: Que tipo de ajuda?**
Check all that apply.

- [ ] Aluguel social
- [ ] Casa em terra nova
- [ ] Dinheiro
- [ ] Coisas/móveis/quarto numa casa
- [ ] Other: _____

27. **Grau de satisfação com a ajuda**
Mark only one oval.

	1	2	3	4	
Totalmente descontente	◯	◯	◯	◯	Muito satisfeito

Preparação

28. **14. Quando você acha que a inundação é mais provável de acontecer? (Marque um ou mais itens)**
Check all that apply.

- [ ] Janeiro
- [ ] Fevereiro
- [ ] Março
- [ ] Abril
- [ ] Maio
- [ ] Junho
- [ ] Julho
- [ ] Agosto
- [ ] Setembro
- [ ] Outubro
- [ ] Novembro
- [ ] Dezembro

29. **15. Você se cadastrou em algum serviço de informação sobre perigo de inundação?**
Mark only one oval.

- ◯ Sim, da INEA
- ◯ Sim, da Defesa Civil
- ◯ Nenhum
- ◯ Other: _____

30. **16. Você conhece o Sistema de Alerta de Cheias do Instituto Estadual do Ambiente (INEA)?**
Mark only one oval.

- ◯ Sim
- ◯ Não

31. **Se sim: Você já visitou alguma vez ou visita a página Web do Sistema de Alerta de Cheias?**
Check all that apply.

- ☐ nunca
- ☐ uma/duas vezes
- ☐ raramente
- ☐ frequentemente
- ☐ regularmente

32. **17. Você conhece os mapas de risco da sua area?**
Mark only one oval.

- ◯ Sim, do serviço geológico (DRM RJ)
- ◯ Sim, da Inea
- ◯ Sim, não sei de onde
- ◯ Não

33. **18. Você se considera informado sobre "o que fazer" em caso de inundação, deslizamento ou perigo? Por que?**
Check all that apply.

- ☐ Sim, por conselho de parentes e amigos
- ☐ Sim, por experiência própria
- ☐ Sim, pelo treinamento das instituições
- ☐ Não, nunca fui informado
- ☐ Other: _____

34. **19. Você acha que você está preparado agora mesmo para um caso de inundação, deslizamento ou perigo? (Sobre formas de contenção, rotas de evacuação, coisas que precisa levar, lugares seguros, etc.)**
Mark only one oval.

- ◯ Acho que estou bem preparado
- ◯ Acho que poderia estar mais preparado
- ◯ Acho que estou pouco preparado
- ◯ Acho que não estou preparado
- ◯ Other: _____

35. **19. Escreva brevemente sobre sua rota de evacuação, e as coisas que precisa levar.**

_____

_____

_____

_____

_____

36. **20. Você já fez parte de uma rotina de evacuação de Defesa Civil?**
Mark only one oval.

- ◯ Sim
- ◯ Não

37. **Você acha que isso foi útil / pode ser útil para você especialmente em relação a ações de perigo de inundação ou deslizamento?**
Mark only one oval.

	1	2	3	4	
Não	◯	◯	◯	◯	Muito

38. **21. Você acha que você conhece os lugares de maior risco na sua cidade?**
Mark only one oval.

- ◯ Conheço muito bem
- ◯ Conheço alguns
- ◯ Conheço poucos
- ◯ Não conheço

39. **22. Você acha que o sinal de alerta é útil em caso de inundação ou deslizamento?**
Mark only one oval per row.

	Muito	Pouco	Não	Não conheço o sinal
Sirene	◯	◯	◯	◯
SMS	◯	◯	◯	◯
Internet	◯	◯	◯	◯

40. **23. Você reage aos sinais de alerta em caso de inundação ou deslizamento?**
Mark only one oval per row.

	Sempre	Frequentemente	Muitas vezes não	Nunca
Sirene	◯	◯	◯	◯
SMS/Telf	◯	◯	◯	◯
Internet	◯	◯	◯	◯

41. **24. Qual das medidas abaixo você acha q é a melhor para a redução de riscos**
Check all that apply.

- ☐ Barragens
- ☐ Reflorestação
- ☐ Muros de contenção
- ☐ Educação da comunidade
- ☐ Limpeza do rio
- ☐ Canalização do rio
- ☐ Other: _____

42. **25. Você acha que a proteção e recuperação das areas verdes e importante para a redução do risco de desastres?**
Mark only one oval.

- ◯ Muito importantes
- ◯ Relativamente importantes
- ◯ Pouco importantes
- ◯ Não fazem diferencia

43. **26. Voce fez/faz recuperação (plantação de árvores) o proteção de areas verdes em sua area?**
Mark only one oval.

- ◯ Nunca
- ◯ Uma vez
- ◯ Muitas vezes
- ◯ Tenho ainda areas verdes
- ◯ Other: _____

44. **Comentários**

_____

_____

Obrigada pelo tempo e apoio! Gostaria de participar mais no tema?

No mes de setembro, a equipe irá realizar discussões da temática em grupos focais e workshops. Se você quer participar dos grupos focais e contribuir para a pesquisa deste tema tão importante, por favor deixe seu nome, telefone e seu email para que possamos contatá-lo, Certificado de participação incluido,

45. **Nome**

_____

46. **Telefone**

_____

47. **Tem Whats App no telefone?**
Check all that apply.

- ☐ Sim
- ☐ Não

48. **Email**

_____

49. **Disponibilidade**
Check all that apply.

- ☐ Segundas
- ☐ Terças
- ☐ Quartas
- ☐ Quintas
- ☐ Sextas
- ☐ Sabados
- ☐ Domingos

50. **Horario**

_____

9.3 Interviews

Place: _____ Date: ____/_____/_____

Name: _____

Institution: _____ National / State/ Municipal / NGO / Private

Position: _____ Since: _____

1. Main responsibilities and priorities of the institution (This can be previously checked on the webpage and general information of the organization)
    a. Objectives/ mission/ vision
    b. Organigram/ structure/ services/ legislation/ projects and publications
    c. Area/region where they work/ share work with
    d. Monetary resources/ funding to and from/ tendencies
    e. Concerning laws/ support and changes
2. Relation, programs, and actions to reduce disaster risk and/or improve disaster risk governance
    a. Actions/ programs covered (preparedness/ response/ recovery/ mitigation)
    b. How are the actions defined/ How long are they planned for/ Since when?
    c. What is the perspective of these actions? How do they change in time?
3. Sources of the information used by the institutions.
    a. Primary information, monitoring/ measuring/ field research
    b. Secondary information from other institutions/ publications/ sources
    c. Processes involving this information
4. Outcomes of the institution
    a. Information (written/ news/ publications/ information sessions)
    b. Working plans/ programs/ exchanges
    c. Infrastructure (subcontracts/ planning/ quantity)
    d. Averages and weights of the inputs and outcomes
5. Relation to other institutions
    a. How important is the existing network? Who is involved? what does it require? is it further developed? How?
    b. Hierarchy/ organization/ communication/ ojectives
    c. Other types of exchanges
6. Relation to the population
    a. How important is participation for the institution? Individually?
    b. Are there participatory approaches being applied?
    c. Existing top – down and bottom -up approaches.

Fung's table

Nome: _____ Data: _____
Cargo: _____

	Instituição_____ / **Programas Participativos:**	**PP1: _____ Descripção:**	**PP2: _____ Descripção:**	**PP3: _____ Descripção:**
	Autoridade e poder			
1	Autoridade direita			
2	Autoridade com supervição			
3	Co-governo			
4	Consulta e conselho			
5	Influença comunicativa			
6	Beneficio pessoal			
7	Educação individual			
	Participantes			
1	Administradores, expertos			
2	Representantes profesionais eleitos			
3	Atores profesionais			
4	Serviços de emergência e especialistas científicos			
5	Selecionado random			
6	Recrutamento de voluntários treinados			
7	Aberto, auto selecionado			
8	Todo mundo, agrupação difusa			
	Comunicação e modo de decição			
1	Expertise tecnica			
2	Deliverar e negociar			
3	Agregar e negociar			
4	Desarollar preferencias			
5	Expresar preferencias			
6	Coleta de dados explícita			
7	Escuitar como espectador			
8	Coleta Implícita de Dados			

Comentarios:

_____

_____

_____

9.4 Focus groups

O projeto INTECRAL faz parte do Ministério da Educação e Pesquisa (BMBF) e Secretaria do Estado de Agricultura e Pecuária do Projeto Rio Rural (SEAPEC-PRR). Este projeto trata-se de um estudo sobre a redução do risco de desastres na bacia do Rio Dois Rios. Os grupos focais têm como objetivo entender e melhorar a competitividade do setor rural, levando em consideração uma gestão sustentável das bacias hidrográficas, incluindo a mitigação do risco ambiental e a proteção dos recursos naturais. Dentro do projeto, será avaliada a gestão dos riscos de inundação e deslizamentos de terra na região da bacia Rio Dois Rios (Nova Friburgo e São Fidéis) para obter uma melhor proteção para os habitantes.

Convite para Discussão em Grupos Focais

Nós gostaríamos de ouvir suas idéias e opiniões sobre os riscos naturais existentes na sua localidade, possibilidades de redução do risco e preparação de risco possíveis. Um mapeamento participativo será realizado, o qual irá recolher todo o conhecimento local em uma ferramenta útil para uso coletivo. Você estará em um grupo com mais 6-9 moradores do bairro. Suas respostas para as perguntas serão mantidas em anonimato. Um certificado de participação será dado no final da discussão do grupo focal e, além disso, uma filmadora HD e kits de sobrevivência serão sorteados no final de novembro.

A data, hora e local estão listados abaixo. Por favor, siga as instruções assim que chegar ao local, direcionando-se para a sala onde o grupo focal será realizado.

Data _____/_____/2015 Hora _____:_____

Lugar_____

Se você precisar de mais informações sobre sua participacao no grupo focal ou não puder atendê-lo por qualquer razão, por favor entre em contato com _____. Caso contrário, estaremos ansiosos para vê-lo!

Atenciosamente

Alicia Bustillos Ardaya
alicia_busti@hotmail.com
Projeto INTECRAL
http://intecral-project.web.fh-koeln.de/

INTECRAL
Integrated eco technologies and services for a sustainable Rural Rio de Janeiro

(POR FAVOR, ENTREGUE ESTA FOLHA PREENCHIDA E ASSINADA)

Anuência de participação no grupo focal

Você foi convidado para participar de um grupos focais organizado pelo projeto INTECRAL, parte do projeto Rio Rural. O propósito do projeto é tentar entender os procesos de risco e o conhecimento local neste tema. A informação aprendida nos grupos focais serão utilizadas para a concepção de mensagens para entidades públicas e destina-se a incentivar as comunidades a ganhar conhecimento adequado sobre os riscos e desastres.

Você pode escolher se quer ou não participar no grupo focal, assim como pode se retirar a qualquer momento. Com o intuito de facilitar a análise dos dados coletados, as dicussões nos grupos focais serão gravadas, porém suas respostas permanecerão anônimas e nenhum nome será mencionado no relatório.

Não há respostas certas ou erradas para as perguntas nos grupos focais. Queremos ouvir muitos pontos de vista diferentes e gostariamos de ouvir a todos. Mesmo quando suas respostas possam nao estar de acordo com aquelas do restante do grupo, por favor, sinta-se à vontade para compartilhar abertamente sua opnião. Em respeito um pelo outro, pedimos que apenas um indivíduo fale por vez e que as respostas feitas por todos os participantes permaneçam confidenciais.

Edade: ◯ 18-30 ◯ 30-40 ◯ 40-60 ◯ >60

Genero: ◯ F ◯ M

Setor: ◯ agrícola/pecuario ◯ industrial ◯ comercial ◯ governamental ◯ otros_____

Qual é a potencialidade da população e da reigião:_____

_____

Eu entendo essa informação e concordo com participar plenamente nas condições indicado acima:

Assinado: _____ Data: _____

INTECRAL
Integrated eco technologies and services for a sustainable Rural Rio de Janeiro

Programa

Sobre o projeto:

Este projecto irá trabalhar com as famílias localizadas em áreas de risco no Estado do Rio de Janeiro (municípios de Nova Friburgo e São Fidélis). A ideia será fazer questionários de percepção para os habitantes dessas áreas e recrutar pessoas interessadas em grupos focais. Em uma segunda fase queremos realizar mais ou menos 5 a 8 grupos focais para 8 a 10 pessoas para obter mais detalhes sobre a sua percepção e trabalhar com mapeamento participativo.

Bem-vinda, introdução sobre o tema, o projeto e os objetivos do grupo focal hoje

1. Eventos anteriores de inundações e deslizamentos de terra na sua memória
2. O que acontece depois de um evento?
3. Quais instituições colaboraram e como?
4. Preparação, medidas tomadas e conhecimento coletado entre os participantes
5. Lugares seguros para evacuação
6. Procedimentos seguros para seguir
7. Aspectos futuros para serem considerados
8. Abordagem ecossistêmica para a redução de riscos
9. Existe alguma coisa mais que você gostaria discutir sobre este assunto?


Bar


Lanchonete Restaurante


Lanchonete Restaurante


D.P.O.

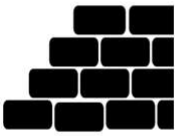

Esgoto


Area verde


Escola


Combustível


Campo de futebol


Muros de contenção


Nascente


Industria


Quadra


Produção agricola


Desmatamento


Agrotoxicos


Contaminação da água


Barragens


Cemetério


Dragagem


Area com seca


Casa interditada abandonada


Igreja


Agua para agricultura


Area com cheia


Casa interditada habitada


Sirene

9.5 Workshops

Redução de Riscos de Desastres: da perspectiva top-down à integração intersetorial

O projeto Intecral (http://intecral-project.web.th-koeln.de) em parceria com o programa Rio Rural (http://www.microbacias.rj.gov.br/pt/rio-rural) tem o agrado de convidar a voces a o workshop:

Redução de Riscos de Desastres: da perspectiva top-down à integração intersetorial

Processos de informação e comunicação dos moradores e as instituições para a redução de perdas em caso de riscos

Data: Segunda, 14 de dezembro, das 08.00 ás 17.30 horas Friburgo, RJ
Lugar: Hotel Bucsky Rodovia RJ 116, Km 76 - Ponte da Saudade, Nova

OBJETIVO DO WORKSHOP:

O Workshop *"Redução de Riscos de Desastres: da perspectiva top-down à integração intersetorial"* pretende abrir espaço aos diversos processos de troca de informação e de comunicação sobre a atual situação de instituições que trabalham com gerenciamento de risco e suas dinâmicas, sobretudo com a participação da sociedade civil nas questões de adaptação e resiliência em casos de risco de desastres.

O Workshop pretende fomentar a discussão entre as instituições e entes envueltos direta e indiretamente sobre os processos necessários para a preparação e os trabalhos com riscos conhecidos ou insurgentes, provenienes de um sistêma dinâmico, como é o caso do Estado do Rio de Janeiro, considerando experiencias passadas e aprendizagens de pesquisas existentes ou em andamento. Além disso, há o intuito de compartilhar perspectivas das instituições e dos grupos comunitários, tendo em vista a atual necessidade da integração intersetorial.

Comfirmações e perguntas sobre o workshop
Alicia Bustillos Ardaya
Projeto INTECRAL – WP4 DRR
FH Köln, Universidad Bonn, Alemanha
aliciabusti@outlook.com
Tel: (22) 999034683

Comfirmações e perguntas sobre hospedagem e o local
Olinéa Cysneiros
Programa Rio Rural - SEAPEC/RJ
Superintendência de Desenvolvimento Sustentável
occysneiros@yahoo.com.br
Tel: 3607-6003 / 3607-5398

PROGRAMAÇÃO WORKSHOP 2015:

08:00 às 09:00: Cadastro dos participantes

09:00 às 10:00h: Apresentações da sociedade civil:

Associação de moradores de Conquista, Barracão dos Mendes, Riograndina, Córrego Dantas.

Participação da sociedade civil relatando os trabalhos e experiências em áreas de risco dentro das comunidades, os casos de sucesso e suas dificuldades, e suas relações com as instituições e outras associações.

10:00 às 11:00h: Apresentações dos resultados das pesquisas:

Laboratório de Geo-Hidroecologia UFRJ, INCID, Projeto Intecral Universidad de Bonn.

Apresentação das pesquisas realizadas por o laboratório de geo-hidroecologia, o INCID e pelo equipe DRR do projeto Intecral sobre redução de risco.

11:00 às 13:00h: Apresentação das instituições:

CIEM-INEA, CPRM, DRM (a confirmar), Defesa Civil, Ministério do Meio Ambiente NF, Ministério Público, Viva Rio (a confirmar).

Participação das instituições envolvidas na preparação, resposta, recuperação e prevenção em casos de riscos de desastre, também apresentando os trabalhos desenvolvidos a partir de 2011, seus casos de sucesso e dificuldades ao longo do processo, além de suas relações com outras instituições e com a sociedade civil.

13:00 às 14:00h: Almoço no hotel Bucsky

14:00 às 16:30h: Formação dos grupos de trabalho e discussão

Início dos trabalhos com os GT's (grupos de trabalho) com as associações e instituições interessadas em integrar informações e conhecimentos para troca de experiências. No começo do workshop, os participantes receberão a programação junto com as definições e a folha para começar o trabalho no workshop da tarde (folha adjunta). A pergunta ”O que você considera relevante para a redução de riscos de desastres dentro da sociedade civil e dentro do poder publico e por que?” será respondida em quatro partes.

Redução de Riscos de Desastres: da perspectiva top-down à integração intersetorial

1º Passo (durante as palestras da manhana + 20 minutos): Cada pessoa irá enumerar de 1 a 5 os pontos que consideram como mais rtimpoantes e/ou relevantes durante as palestras apresentadas na primeira parte do workshop.

2º Passo (aprox. 20 minutos): Dentro da mesma mesa de trabalho iremos trocar os questionários, passando nossas folhas para o lado direito. Uma vez que recebermos as folhas do participante a nossa esquerda, iremos analizar e enumerar os pontos descritos pelo colega, de acordo com nossa opinião de importância ou prioridade.

3º Passo (aprox. 30 minutos): Uma vez que todos avaliaram a opinião do outro colega, passaremos os questionarios uma última vez à direita. A proxima etapa consiste em qualificar (concordo; não concordo; acho mais importante...) e argumentar, no espaco indicado no questionário, a discussão apresentada pelos dois colegas a sua esquerda. OBS: No paso 2 e 3, os participantes podem e devem fazer perguntas aos respectivos colegas de mesa afim de tentar compreender a opinião dos mesmos.

4º Passo (aprox. 1 hora): Agora é hora de discutirmos as conclusões de forma mais ampla. A mesa irá buscar um consenso para evidenciar os aspectos mais recorrentes e importantes discutidos através dos passos anteriores. Iremos escrever, em no máximo 5 cartões (que serão disponibilizados pela equipe DDR), os principais pontos que foram considerados na mesa.

16:30 às 17:30h: Apresentação das conclusões e fechamento do workshop:

Conclusões da troca de experiência dos GT's e finalização do workshop.

INTECRAL
Integrated eco technologies and services for a sustainable Rural Rio de Janeiro

RIO RURAL

O projeto Intecral (http://intecral-project.web.th-koeln.de) em parceria com o programa Rio Rural (http://www.microbacias.rj.gov.br/pt/rio-rural) tem o agrado de convidar a voces a o workshop:

REDUÇÃO DE RISCOS E VULNERABILIDADE: INTEGRAÇÃO DE PROCESSOS INTERSETORIAIS

Processos de informação e comunicação dos moradores e as instituições para a redução de perdas em caso de riscos

Data: Sexta, 16 de dezembro 2016, das 08.30 ás 17.30 horas
Lugar: Senai centro, Rua Prefeito Eugenio Müller 220. Nova Friburgo, RJ

OBJETIVO DO WORKSHOP: O Workshop "Redução de Riscos e Vulnerabilidade: Integração De Processos Intersetoriais" pretende abrir espaço aos diversos processos de troca de informação e de comunicação sobre a atual situação de instituições que trabalham com gerenciamento de risco e suas dinâmicas, sobretudo com a participação da sociedade civil nas questões de adaptação e resiliência em casos de risco de desastres.

O Workshop pretende fomentar a discussão entre as instituições e entes envolvidos direta e indiretamente sobre os processos necessários para a preparação e os trabalhos com riscos conhecidos ou insurgentes, provenienes de um sistêma dinâmico, como é o caso do Estado do Rio de Janeiro, considerando experiencias passadas e aprendizagens de pesquisas existentes ou em andamento. Além disso, há o intuito de compartilhar perspectivas das instituições e dos grupos comunitários, tendo em vista a atual necessidade da integração intersetorial. Redução de Riscos de Desastres: da perspectiva top-down à integração intersetorial

Comfirmações e perguntas sobre o workshop:

Alicia Bustillos Ardaya
aliciabusti@outlook.com
Tel: (22) 981292808
W.A. +49 17697916511

Conrado Werneck Pimentel
conradopimentel@gmail.com
Tel/W.A: 21 98294 0068

INTECRAL
Integrated eco technologies and services for a sustainable Rural Rio de Janeiro

RIO RURAL

PROGRAMAÇÃO WORKSHOP 2016:

REDUÇÃO DE RISCOS E VULNERABILIDADE: INTEGRAÇÃO DE PROCESSOS INTERSETORIAIS

Neste ano, a equipe Disaster Risk Reduction – DDR – do projeto INTECRAL finalizará os trabalhos iniciados em 2014 com um workshop voltado para instituições e sociedade civil, visando a troca de experiências setoriais.

Iniciaremos o dia com o cadastramento dos participantes, seguido de uma roda de abertura de apresentações gerais. O workshop será dividido em 3 partes – uma antes do almoço e duas depois.

A metodologia consiste no preenchimento de tabelas, informando os produtos prioritários que cada uma das instituições/órgãos são responsáveis por fazer, assim como suas fontes, a frequências e destinatários destes mesmos produtos dentro do sistema de comunicação, incluindo moradores de áreas de risco.

Ao fim, teremos a apresentação das conclusões dos trabalhos. Contamos com a participação do CEMADEN-RJ, CPRM, DRM, Defesa Civil, Cruz Vermelha, Viva Rio, INCID, FioCruz, e dos representantes das associações de moradores de Córrego D'Antas, Barracão dos Mendes, Riograndina e Campo do Coelho.

PROGRAMAÇÃO:

08:30 às 09:00h – Cadastramento

09:00 às 10:00h – Roda de apresentações + Exposição dos questionários 2015

10:00 às 12:00h – Exercício com os produtos de cada instituição/órgão

12:00 às 13:00h – Almoço

13:00 às 15:00h – Construção da relação dos produtos + Apresentação da síntese do workshop 2015 15:00 às 16:30h – Trabalho com a relação dos produtos e sínteses

16:30 às 17:30h – Conclusão

Qualquer dúvida, a equipe DDR está ao seu dispor para ajudá-lo(a).

Att, Alicia Bustillos, Conrado Pimentel