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Overview of risks associated with heavy rainfall in Niterói – RJ

Panorama de riscos associados às chuvas intensas em Niterói – RJ

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ABSTRACT

Natural disasters are surprising events that cause immeasurable losses, and it is a topic that has been discussed worldwide. Heavy and/or prolonged rainfall can cause disasters, catastrophes of gigantic proportions. In Brazil, the Southeast, South and Northeast regions suffer from this problem more recurrently. Inserted in this context, Niterói, one of the most important cities in the State of Rio de Janeiro, presents, especially in the summer months, disasters associated with intense and/or prolonged rains, such as flooding, flooding and mass movements. This paper presents an overview of these disasters and their evolution in recent years, with the purpose of contributing to a better understanding of the risks that are associated with these disasters and the impacts on the urban site of the Municipality of Niterói. From the panorama presented, the city remains vulnerable to the event of heavy rain, since the associated disasters occur frequently in the same affected locations, which points to a possible lack of risk mitigation in most places that present this recurrent behavior.

Keywords: Precipitation, Environmental hazards, Risk areas, Landslides.

INTRODUCTION

This text addresses the rapid and unbridled growth of some Brazilian cities, resulting in poor urban planning, especially in drainage infrastructure. The lack of maturity in environmental and urban debates leads to serious consequences, especially for the population in vulnerable areas. The C40 Group points out that metropolises consume a large part of global energy and emit significant CO2.

Urban sprawl generates heat islands due to the replacement of vegetation with pavement, influencing the local and global climate. These changes affect the dispersion of pollutants, intensity of storms, and the health of inhabitants, especially the most vulnerable. Drainage problems are also highlighted, with urbanizations altering the natural dynamics of hydrological flows, increasing flooding, and impacting low-lying coastal zones, where a significant portion of the world's population resides.

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The text justifies the need to study the conditions faced by the city of Niterói in the face of heavy rain events, to present an overview of the affected areas, especially in relation to landslides and flooding. The specific objectives include analyzing the local rainfall dynamics, evolution of the perception of susceptible areas and evaluation of the municipal administration's view of these events.

GENERAL RISK CONSIDERATIONS

The text addresses the theme of environmental risks, starting with several definitions of risk by different authors. Miranda Neto (2002) conceptualizes risk as the possibility of an illness occurring that can be harmful to human health, the environment, physical structures, patrimony or the economy. Dagnino and Carpi Junior (2007) define it as the probability of an event materializing, while Veyret and Richemond (2007) condition the existence of risk to the presence of a population that may suffer its negative effects.

The author Tckeskiss (2010) highlights the evolution of awareness about environmental risks throughout history, moving from metaphysical explanations to a scientific approach. Castro (2000) highlights the increased attention to environmental risks from the 1980s onwards, with the transition from nuclear safety concerns to environmental issues.

Lourenço and Amaro (2018) propose a globalizing and systemic approach to understand different types of risks, from their natural, anthropogenic origin to their social consequences. Costa (2011) points out that environmental risk is a process related to the modern way of life, not only linked to catastrophic events, but also to processes over time.

The text emphasizes the importance of prior planning and careful execution of interventions in the urban environment, correlating current phenomena with those that may arise after changes. Ulrik Beck underscores the future nature of the risks, based on the anticipation of destruction that has not yet occurred.

Lourenço and Amaro (2018) highlight the importance of environmental education and technical-scientific knowledge in reducing risk. They classify environmental risks as natural, anthropogenic or mixed. Bernardes and Nehme (2012) warn of socio-environmental risks, which affect both the physical and social environment.

The text also addresses the integrated view of natural and technological systems and anthropic actions in the concept of environmental risk proposed by Egler (1996). Veyret and Richemond (2007) relate natural hazards to physical events beyond human control, while Fernandes & Rocha (2007) define technological hazards as related to various technologies.

Social risks are associated with the insecurity of populations in relation to the malfunctioning of social structures, such as social exclusion, unemployment and violence. Beck (2010) points out that environmental problems are, in fact, social problems, related to history, living conditions and the relationship of human beings with the world.

COBRADE in Brazil classifies disasters into natural and technological, with specific subcategories. The text highlights the conceptual confusion between risk, danger, and catastrophe in dictionaries, clarifying that risk relates to the probability of threats materializing, while danger refers to potential threats.

The concept of vulnerability is discussed, associated with both risk and danger, representing the fragility of a community in the face of processes or phenomena. Authors such as Hogan et al. (2001) and Fankhauser and McDermott (2014) highlight the social dimension of vulnerability, related to the ability of more affected populations to protect themselves from risks.

The text differentiates between disaster, catastrophe and calamity, highlighting that disaster refers to unintentional events that cause damage, while catastrophe is related to the magnitude of that damage. Calamity occurs when damage compromises the functioning of the social organization. Resilience is presented as the ability of a system to adapt to changes resulting from a crisis and improve its ability to respond to future catastrophes.

Finally, the text discusses stability as the ability of a social organization to return to a state of equilibrium after a temporary disturbance. The risk area is defined as one that can be affected by natural or induced phenomena that cause adverse effects.

HYDROLOGICAL RISKS

The text addresses hydrological risks, highlighting natural and anthropogenic factors that contribute to events such as flash floods, floods, and flooding. According to Freitas and Ximenes (2012), natural factors include the volume of rainfall over a watershed, time, and relief and soil characteristics. Amaral and Ribeiro (2012) add that sandy soils facilitate absorption, while clayey soils hinder it, influencing surface runoff. Human action, such as urbanization and soil sealing, increases surface runoff, causing flooding, and is also impacted by actions such as rectifications, channeling and inadequate disposal of debris.

Allard (2000) suggests that occupying risk areas can be economically rewarding, despite the damage. Amaral and Ribeiro (2002) highlight the importance of respecting preservation areas around rivers to avoid flooding. Regarding control, Tucci (1997) proposes structural (extensive and intensive) and non-structural measures. Structural projects involve large-investment works to

reduce risks, such as dikes and reservoirs. The non-structural ones seek to avoid losses at lower costs, including regulation of urban occupation, restriction of construction in risk areas, purchase of flood areas, population transfer, contracting of insurance, forecasting systems and evacuation plans. Intensive, unconventional measures, such as Low Impact Development, aim to reproduce natural runoff, requiring proper maintenance.

CONCEPTS RELATING TO MASS MOVEMENTS

The text addresses concepts related to mass movements, highlighting their importance due to the economic and social impacts and their influence on the evolution of the slopes. Infanti Júnior and Fornasari Filho (1998) explain that slope characteristics, such as slope and morphological evolution, are crucial to understand mass movements. Cruden (1991) defines mass movement as the displacement of rocks, soil or debris along a slope, and Varnes (1978) classifies it into falls, overturns, landslides, lateral expansions and flows.

The text addresses the relationship between rainfall and mass movements, highlighting that movements triggered by rainfall are generally called landslides. The decrease in soil shear strength due to rainfall infiltration is discussed, explaining how pore pressure affects slope stability. Soil permeability, vegetation and natural factors are also considered. Pedrosa (1994) points out that the prediction of mass movements is complex, involving factors such as the thickness of the weathering profile, soil properties, vegetation cover, among others.

The text emphasizes the importance of the Geographic Information System (GIS) in the analysis of correlations between rainfall and mass movements. Statistical methods, mathematical models and geotechnical instrumentation are cited as tools to study this relationship. Soares (2006) presents categories of methods that relate rainfall and landslides, such as correlation of precipitation with probability of landslide and mathematical models for predicting soil water level variation. GIS is highlighted as an effective tool for complex analysis and integration of georeferenced information.

GENERAL ASPECTS OF THE MUNICIPALITY OF NITERÓI

The municipality of Niterói, located in the state of Rio de Janeiro, faces challenges of demographic growth and urban expansion, being affected by rainy events that cause inconvenience to the population. With an estimated population of 516,981 people, the city has a geographical distribution in 52 neighborhoods, grouped into five administrative regions. The region Beaches of the Bay, North, Oceanic, Pendotiba and East are the main areas.

Geologically, Niterói is located on terrains of polycyclic evolution, associated with the Coastal Mobile Belt or Ribeira Belt, with granitoid and metamorphic rocks. The Niterói Ductile Shear Zone exhibits seven main fault zones. The city has different lithological units, such as Angelim Unit, Catalonia Unit, Phasoidal Gneiss Unit, Cassorotiba Unit and Itaipú Sub-Unit.

The geomorphology of the region is characterized by gentle and moderate gradients, rounded tops and soils originating from gneissic rocks. The relief near the coast consists of strips of plains interrupted by hills. The original vegetation is from the Atlantic Forest, with preserved areas in the Serra da Tiririca, floodable fields, mangroves and sandbanks. The climate is tropical, with high rainfall in the summer and a dry winter.

Niterói faces environmental challenges, such as landslides, especially the incident in Morro do Bumba in 2010. A detailed understanding of geology, geomorphology, and vegetation cover is crucial to address natural hazards and promote the sustainable development of the municipality.

METHODOLOGY AND PRIMARY SOURCES OF DATA

The methodology used in the research on flooding and landslide events in Niterói involves the analysis of the interaction between historical rainfall series and hydrological and geological occurrences. Information was obtained from municipal agencies, higher education institutions and researchers. The study includes the characterization of the urban geosystem, urbanization history, watercourses, relief, areas with drainage problems and actions of the public authorities. Data from the Civil Defense and local press were used, as well as reports from the Municipal Secretariat of Civil Defense and Geotechnics of Niterói, covering the period from 2011 to 2022.

RESULTS

The text addresses the urban system of Niterói, Rio de Janeiro, focusing on demographic issues, urban planning and natural hazards, especially related to heavy rainfall. Here's a rundown of the main sections:

NITERÓI URBAN GEOSYSTEM

- Population of Niterói exceeds 500 thousand inhabitants.
- The entire municipality is considered urban.
- The City sent a new Urban Law to the Legislature to guide urban transformation.

HEAVY RAINS IN NITERÓI

- Heavy rainfall can cause geological disasters (mass movement) and hydrological disasters (flash floods).
- The events are related to geology, topography, land use, and intense weather events.
- Climatic data from Niterói show seasonal and annual variations in rainfall.

ASSESSMENT OF LANDSLIDE RISK AREAS

- Various methods for assessing landslide risks, including map analysis, aerial reconnaissance, and soundings.
- Risk classification based on history, types of movements, scope of events and resistance of buildings.

HIGH AND VERY HIGH RISK POINTS IN THE CITY OF NITERÓI

- The Municipal Law mentions nine points of very high risk in 2004.
- In 2007, a Risk Reduction Plan identified 142 risk points.
- In 2022, the Civil Defense mentions 138 risk points, classified into five risk levels.
- Tables detail risk points in different administrative regions of Niterói over the years.

CONCLUSION

There has been an apparent increase in the number of risk points over the years, but the changes can be attributed to different methods of classification and location accuracy.

The risk classification in 2022 considers five levels, indicating different degrees of risk in the affected areas.

The text highlights the need for a comprehensive approach to dealing with natural disasters, with an emphasis on structural and non-structural measures, and highlights the evolution in risk management policies over time.

The city of Niterói originates from territorial occupation in colonial Brazil with progressive growth and urban expansion over hillside and lowland areas, including lowland areas that were filled in. For 140 years, until 1975, the city was the capital of the state, experiencing population growth, especially after the inauguration of the Rio-Niterói bridge in 1974. All this expansion, combined with social, geographical, and spatial conditions, may have aggravated hodrological and geological processes such as floods and mass movements that are present in current times.

Despite the municipality's efforts to control, map or mitigate the frequent disasters that plague the city, affect the population and the connecting roads that serve users in transit through the municipality, episodes of natural disasters always seem to be present.

This study concluded that there is still a considerable number of risk points subject to landslide processes. The risk areas in the years 2004, 2007 and 2022 were organized on a temporal scale in order to assess, in a literature search, whether there had been an evolution of the risk scenarios. However, the methodological changes in the classification of the degree of risk of the records made over time have undergone changes that have made it impossible to assess whether there has been a reduction in risk in certain places, such as an area going from very high risk to low risk or vice versa.

Also, the way in which the records of 2004, 2007 and 2022 were located did not allow us to accurately determine whether a locality has evolved in its risk classification, since for a given area, without a precise address, it cannot be said that a certain event or risk situation has been mitigated, is still present or if a new event has appeared in the area.

These difficulties allow us to conclude that historical data would be more consistent if rigorous routines were adopted for locating and classifying risk areas, avoiding changes over time that have the potential to make an analysis of temporal evolution unfeasible.

Therefore, it can be concluded that, at present, something around 50% of the areas considered to be at risk are historical sites, recorded more than a decade ago in the mappings made.

It is suggested, as a future work, that the risk areas of 2022, presented in this study, be refined, aiming at their classification, and that the locations can be subject to physical verification of the addresses to enable a monitoring of the evolution over time and to verify future actions adopted by the municipality in order to mitigate the risks then pointed out in 2022.

It is recommended that an adequate survey of the places and conditions of risk can be carried out to enable the design of public policies such as zoning of areas, occupational relocation, works, information campaigns, direction and prioritization of resources that can lead to a position of reduction of the risks that are currently present in the municipality.

REFERENCES

Alves, H. P. F. (2007). Desigualdade ambiental no município de São Paulo: análise da exposição diferenciada de grupos sociais a situações de risco ambiental através do uso de metodologias de geoprocessamento. Revista Brasileira de Estudos de População, 24, 301-316.

Amaral, R. do, & Ribeiro, R. R. (2012). Inundação e Enchentes. In L. K. Tominaga, J. Santoro, & R. do Amaral (Org.), Desastres naturais: conhecer para prevenir (pp. 39-52). São Paulo: Instituto Geológico.

Aristizábal, E., Martínez, H., & Vélez, J. I. (2010). A review on the study of mass movement triggered by rains (in Spanish). Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales, 34(131), 119-227.

Ávila, M. W. de, et al. (2016). Gestão qualitativa dos recursos hídricos – proposta metodológica para o planejamento de uma rede de estações para monitoramento da qualidade de águas superficiais – estudo de caso: bacia hidrográfica do Rio Muriaé. RBRH, 21(2), 401-415.

Beck, U. (2010). Sociedade de risco: rumo a uma outra modernidade. São Paulo: Ed 34.

Bernardes, M. B. J., & Nehme, V. G. F. (2012). Educação Ambiental: um aporte para o exercício da cidadania. In A. P. Portuguez, G. F. Seabra, & O. T. M. M. Queiroz (Org.), Turismo espaço e estratégias de desenvolvimento local. João Pessoa: Ed. UFPB.

Brasil. Ministério das Cidades. Instituto de Pesquisas Tecnológicas. (2007). Mapeamento de risco em encostas e margem de rios. Brasília: Ministério das Cidades; IPT. Recuperado de link.

Brasil. (2012). Lei Nº 12.651, Dispõe sobre a proteção da vegetação nativa. Recuperado de link.

Carmo, R. L., & Silva, C. A. M. (2009). População em zonas costeiras e mudanças climáticas: redistribuição espacial e riscos. In D. J. Hogan & E. J. Marandola Jr. (Orgs.), População e mudança climática: dimensões humanas das mudanças ambientais globais (pp. 137-157). Campinas: Núcleo de Estudos de População (NEPO/Unicamp); Brasília: UNFPA.

Castro, S. D. Aneas de. (2000). Riesgos y peligros: una visión desde lá Geografía. Scripta Nova: Revista Electrónica de Geografía y Ciencias Sociales, 60. Recuperado de link.

Climate-Date. (2022). Disponível em https://en.climate-data.org/south-america/brazil/rio-de-janeiro-208/. Acessado em 01/06/2022.

Cobrade – Classificação e Codificação Brasileira de Desastres. (2022). Ministério do Desenvolvimento Regional, Brasília DF. Acessado em 14/09/2022. Disponível em https://www.gov.br/mdr/pt-br/centrais-de-conteudo/publicacoes/protecao-e-defesa-civil-sedec/DOCU_cobrade2.pdf.

Collins, B. D., & Znidarcic, D. (2004). Stability Analyses of Rainfall Induced Landslides. Journal of Geotechnical and Geoenvironmental Engineering, 130(4), 362-372.

Costa, R. A. (2011). Riscos Ambientais em Cidades Pequenas do Cerrado Brasileiro. In G. F. Seabra (Org.), Educação Ambiental no Mundo Globalizado: Uma ecologia de riscos, desafios e resistências (pp. 199-214). João Pessoa: EdUFPB.

Crosta, G., & Frattini, P. (2003). Distributed Modeling of Shallow Landslides Triggered by Intense Rainfall. Natural Hazard and Earth System Sciences, 3, 81-93.

Cruden, D. M. (1991). A Simple Definition of a Landslide. Bulletin of the International Association of Engineering Geology, 43(1), 27-29.

Cunha, B. P. da. (2016). O antes do Bumba: análise do sistema político sob a ótica das teorias estruturalistas-construtivistas de risco (Dissertação de mestrado, UFF).

Dagnino, R., & Carpi Junior, S. R. (2007). Risco ambiental: conceitos e aplicações. CLIMEP Climatologia e Estudos da Paisagem, 2(2), 50-87.

Di Giulio, G., & Ferreira, L. da C. (2013). Governança do risco: uma proposta para lidar com riscos ambientais no nível local. Revista Desenvolvimento e Meio Ambiente, 28, ano 10.

Dolif, G., & Nobre, C. A. (2012). Melhorar as previsões de precipitação extrema no Rio de Janeiro: Os padrões sinóticos são eficientes para distinguir episódios comuns de chuvas fortes? Revista Ciências Atmosféricas, maio.

Egler, C. A. G. (1996). Risco ambiental como critério de gestão do território: Uma aplicação à zona costeira brasileira. Revista Território, 1(1), 31-41.

Francisco, W. de C. e. "População do Rio de Janeiro". (s.d.). Brasil Escola. Recuperado de link.

Fankhauser, S., & McDermott, T. K. J. (2014). Understanding the adaptation deficit: Why are poor countries more vulnerable to climate events than rich countries. Global Environmental Change, 27, 9-18.

Ferrari, M. P., Grossi, F., & Wendling, I. (2004). Propagação vegetativa de espécies florestais. Colombo: EMBRAPA. (Documentos, 94).

Fernandes, B. de J., & Rocha, G. C. (2007). Educação sobre riscos ambientais e o Programa “Defesa Civil nas Escolas”: uma proposta metodológica interdisciplinar. Virtú, 5, jan./jun.

Figueiredo, L. (2021, 09 de novembro). Aumento do gabarito em Charitas para prédios de até 15 andares provoca polêmica. A Seguir: Niterói por Niterói. Recuperado de https://aseguirniteroi.com.br/noticias/grave-violacao-do-plano-diretor-diz-membro-do-compur-sobre-aumento-do-gabarito-em-charitas/.

Freitas, C. M. de, & Ximenes, E. F. (2012). Enchentes e saúde pública: uma questão na literatura científica recente das causas, consequências e respostas para prevenção e mitigação. Revista Ciênc. saúde coletiva, 17(6), Jun 2012.

Fonseca, R. G. (2017). RISCO HIDROLÓGICO: Precipitações extremas, enchentes e alagamentos na cidade de Ituiutaba (MG) (Trabalho de conclusão de curso, Instituto de Geociências e Ciências Exatas, Câmpus de Rio Claro).

Fonseca, R. G., & Christofoletti, A. L. H. (2021). Riscos ambientais, precipitações e implicações socioespaciais urbanas. In A. R. Guimarães, R. G. Fonseca, & S. Fernandes (Orgs.), Perspectivas Geográficas (pp. 29-42). Ituiutaba: Barlavento.

Galvão Filho, J. B., & Newman, D. (2001). Gestão e gerenciamento de risco ambiental. Revista Banas Ambiental – Ano II – nº 12 – Junho de 2001.

Gonçalves, J. S. (2015). Avaliação da Previsão Numérica Sazonal de Precipitação para o Rio Grande do Sul (Dissertação de Mestrado, Programa de Pós-Graduação em Meteorologia, Universidade Federal de Santa Maria).

Hernandez, L. C., & Szigethy, L. (2020). Tecnologia e inovação para a redução do risco de crises hídricas. IPEA. Disponível em: https://www.ipea.gov.br/cts/pt/central-de-conteudo/artigos/artigos/104-tecnologia-e-inovacao-para-a-reducao-do-risco-de-crises-hidricas.

Hogan, D. J., Cunha, J. M. P. da, Carmo, R. L. do, & Oliveira, A. A. B. de. (2001). Urbanização e Vulnerabilidade Sócio-Ambiental: O caso de Campinas. In D. J. Hogan, R. Baeninger, J. M. P. da Cunha, R. L. do Carmo (Orgs.), Migração e ambiente nas aglomerações urbanas (pp. 395-418). Campinas: Nepo/Unicamp.

IBGE – Instituto Brasileiro de Geografia e Estatística. (2022). Cidades e Estados, 2022. Disponível em https://www.ibge.gov.br/cidades-e-estados/rj/niteroi.html.

Infanti Júnior, N., & Fornasari Filho, N. (1998). Processos de Dinâmica Superficial. In A. M. S. Oliveira & S. N. A. Brito (Eds.), Geologia de Engenharia (pp. 131-152). Oficina de Textos.

Leal, T. S., & Leao, O. M. (2020). Analise da Evoluçao da Ocupaçao Urbana e dos Aspectos Socioeconomicos na Bacia Hidrografica Rio Joao Mendes, Niteroi – RJ: Contrituiçao a Gestao Ambiental. Geografia (Londrina), 29(1), 107–123.

Leme, M. C. da S. (1999). A formação do pensamento urbanístico no Brasil, 1895- 1965. In M. C. da S. Leme (Org.), Urbanismo no Brasil. 1895-1965 (pp. 20-38). São Paulo: Studio Nobel, FUPAM.

Lourenço, L., & Amaro, A. (Coords.). (2018). Riscos e Crises: da teoria à plena manifestação. Série Riscos e Catástrofes, Vol. 6, Coimbra: Imprensa da Universidade de Coimbra.

Maia, D. C. (2007). Impactos Pluviais na área urbana de Ribeirão Preto – SP (Tese de Doutorado em Geografia, IGCE, Universidade Estadual Paulista, Rio Claro).

Miranda Neto, M. I. (2002). Investigação geoambiental em área de mangue na Baía de Guanabara contaminada com resíduos industriais (Dissertação de Mestrado em Engenharia Civil, Universidade Federal do Rio de Janeiro, COPPE).

Martins, A. M. B. Bedran. (2016). Avaliação dos impactos de políticas públicas de transferência de renda na qualidade de vida no semiárido nordestino face às mudanças climáticas (Tese de Doutorado em Ciências, Universidade de São Paulo).

Moreno, M. A. F. (2018). Repensando os riscos, com um olhar desde os territórios. In L. Lourenço & A. Amaro (Riscos e crises: da teoria à plena manifestação, pp. xx-xx). Coimbra: Imprensa da Universidade de Coimbra.

Moura, M. V. dos S. (2018). Avaliação do comportamento de contenções em Niterói (Dissertação de Mestrado, UFRJ, Rio de Janeiro).

Nascimento, A. M. M., & Nascimento, E. A. (2022). Analise de Dados Pluviometricos para a Prevençao de Riscos de Instabilidade de Encostas no Municipio de Niteroi. Revista Ibero-Americana de Humanidades, Ciências e Educação, 8(3), 182–195.

Niterói. (2004). Plano Diretor de Niterói. Lei Municipal Nº 2123 de 4/2/2004. Disponível em: http://www.pgm.niteroi.rj.gov.br/leis/lei/Lei_n1157_Plano_Diretor_Alterado_pela_Lei_2123.pdf.

Nogueira, D. (2016). Risco x Perigo: há diferença entre eles? AMBIENTESST, 10 de Maio de 2016. Disponível em: https://ambientesst.com.br/risco-x-perigo/.

Oliveira, J. C. (1995). Desastres ambientais e a responsabilidade do Estado: enchentes, vendavais e deslizamentos. São Paulo: Edipro.

PBMC. (2016). Impacto, vulnerabilidade e adaptação das cidades costeiras brasileiras às mudanças climáticas: Relatório Especial do Painel Brasileiro de Mudanças Climáticas (Marengo, J.A., Scarano, F.R. (Eds.)). Rio de Janeiro, Brasil.

Pedrosa, M. G. A. (1994). Análise de Correlações entre Pl

Penha, H. M., Mendes, J. C., Ludka, I. P., Guimarães, A. M., Almeida, F., & Penha, L. L. (2001). Geologia do granitoide Itacoatiara, RJ: Resultados preliminares. 35º Simp. Geol. Sudeste, SBG, Bol. de Resumos.

Pina, M. F., & Santos, S. M. (2000). Conceitos Básicos de Sistemas de Informação Geográfica e Cartografia Aplicados à Saúde. OPAS, Brasília, 1 vol., 122 p..

Porto-Gonçalves, C. W. P. (1990). Os (des)caminhos do meio ambiente (2ª ed.). São Paulo: Contexto.

PMN - Prefeitura de Niterói. (2007). Plano Municipal de Redução de Riscos do Município de Niterói (PMRR). Niterói.

PMN - Prefeitura de Niterói. (2015). Plano Municipal de Saneamento Básico (PMSB): Diagnóstico, Descrição e Análise Crítica do Sistema de Drenagem e Manejo das Águas Pluviais Urbanas (p. 36). Secretaria Municipal de Conservação e Serviços Públicos.

PMN - Prefeitura de Niterói. (2022d). Mapa hidrológico do Município de Niterói. Secretaria Executiva de Niteroi. Sistema de Gestão da Geoinformação – SIGeo. Disponível em https://dados-geoniteroi.opendata.arcgis.com/datasets/geoniteroi::hidrografia/about. Acessado em: 14/02/2022.

PMN - Prefeitura de Niterói. (2022d). Niterói sobe no ranking nacional de saneamento. Publicado em 15 de junho de 2021. Disponível em: https://www.seconser.niteroi.rj.gov.br/noticias/niteroi-sobe-no-ranking-nacional-de-saneamento. Último acesso em 03/05/2022.

PMN - Prefeitura de Niterói – Secretaria de Meio Ambiente, Recursos Hídricos e Sustentabilidade de Niterói (SMARHS). (2022c).

PMN - Prefeitura de Niterói – Secretaria Municipal de Defesa Civil e Geotecnia de Niteroi (SMDCG). (2022d). Dados abertos/Areas de Risco de Niteroi 2022. Disponível em: https://www.sigeo.niteroi.rj.gov.br/datasets/%C3%A1reas-de-risco-defesa-civil-1/explore?location=-22.903396%2C-43.079600%2C13.25. Acessado em 03/05/2022.

PMN - Prefeitura de Niterói. (2021). Na semana do Meio Ambiente, Niterói ganhará a oitava Unidade de Conservação. Disponível em: http://www.niteroi.rj.gov.br/2021/05/28/na-semana-do-meio-ambiente-niteroi-ganhara-a-oitava-unidade-de-conservacao/. Último acesso em 03/05/2022.

Queirós, M., Vaz, T., & Palma, P. (2007). Uma reflexão a propósito do risco. In Congresso de Geografia Portuguesa, 6, Anais (pp. 1-23). Lisboa: Associação Portuguesa de Geógrafos.

Reginensi, C. (2020). A experiência dos itinerários e o uso das imagens em situação de risco. In Sociologia pragmática das transformações em diálogo. Editora Milfontes: Vitória.

Reid, M. E. (1997). Slope instability caused by small variations in hydraulic conductivity. Journal of Geotechnical and Geoenvironmental Engineering, 123(8), 717-725.

Reis, A. (2007). Alteração ambiental e recursos naturais: Fontes de desestabilização social e de risco e ameaça à segurança nacional e internacional. Inforgeo (Riscos e Ambiente), Lisboa, 67-84.

Ribeiro, G. L. (2008). Poder, rede e ideologia no campo do desenvolvimento. In Revista Novos Estudos, CEBRAP, 27(80), 109-125.

Ribeiro, H., Pesquero, C. R., & Coelho, M. S. Z. S. (2016). Clima urbano e Saúde: uma revisão sistematizada da literatura recente. Scielo, 30(86), 67–82.

Silva, M. V. (2012). As Áreas de Preservação Permanentes Urbanas Sustentáveis e usos Alternativos na Lei nº 12.651/2012. XXI Congresso Nacional do CONPEDI Tema: O Novo Constitucionalismo Latino Americano: desafios da sustentabilidade 31 de outubro a 03 de novembro de 2012 UFF/Niterói – RJ (p. 5).

Silva, D. C. O. (2006). Aplicação do Modelo Shalstab na Previsão de Deslizamentos em Petrópolis. Dissertação de Mestrado, COPPE, UFRJ, Rio de Janeiro, RJ.

Silva, et al. (2014). Vulnerabilidade e variações de curto prazo da praia de Itaipu (Niterói-RJ) em resposta às mudanças nas condições de mar. Rev. Tamoios, São Gonçalo (RJ), 10(2), 69-79.

Soares, E. B. M. de. (1987). História política do Estado do Rio de Janeiro (1889-1975). Niterói: Imprensa Oficial.

Soares, E. P. (2006). Caracterização da precipitação na região de Angra dos Reis e a sua relação com a ocorrência de deslizamentos de encostas. Dissertação de Mestrado, COPPE, UFRJ, Rio de Janeiro, RJ.

Souza, M. L. M. T. (2011). Desastre Natural na Conjuntura Urbana Atual: A Catástrofe Proveniente das Fortes Precipitações Pluviométricas Ocorridas em Abril de 2010, em Niterói - RJ. Dissertação de Mestrado Profissional, Universidade Federal Fluminense, Niterói.

Suárez, B. E. S. (2005). Análise Morfotectônica e Morfométrica do Município de Niterói – RJ. Dissertação de Mestrado em Geologia e Geofísica Marinha, Instituto de Geociências, Universidade Federal Fluminense, Rio de Janeiro.

Tckeskiss, L. A. (2010). Materialismo Histórico em 14 Lições. Lição II: A Hierarquia das Ciências. Arquivo Marxista na Internet. https://www.marxists.org/portugues/tematica/1922/materia/cap02.htm.

Thouret, J-C. (2007). Avaliação, prevenção e gestão dos riscos naturais nas cidades da América Latina. In Y. Veyret (Org.), Os riscos: o homem como agressor e vítima do meio ambiente (p. 83-112). São Paulo: Contexto.

Toll, D. G., Tsaparas, I., & Rahardjo, H. (2001). The influence of rainfall sequences on negative pore-water pressures within slopes. 15th International Conference on Soil Mechanics and Geotechnical Engineering. ICSMGE, Istanbul, Turkey, 2, 1269-1272.

Tucci, C. E. M. (1997a). Água no meio urbano. Disponível em: http://www.pec.poli.br/sistema/material_disciplina/fotos/%C3%A1guanomeio%20urbano.pdf. Acesso em: 14 ago. 2017.

Varnes, D. J. (1978). Slope movement types and processes. In R. L. Schuster & R. J. Krizek (Eds.), Landslides, Analysis and Control (pp. 11-33). Transportation Research Board – Comission on Sociotechnical Systems – National Research Council, National Academy of Sciences, Washington, USA.

Veillard-Baron, H. (2007). Os riscos sociais. In Y. Veyret (Org.), Os riscos: o homem como agressor e vítima do meio ambiente (p. 275-316). São Paulo: Contexto.

Veyret, Y., & Richemond, N. M. (2007). "O risco: Definições e vulnerabilidades do risco". In Y. Veyret (Org.), Os riscos: o homem como agressor e vítima do meio ambiente (pp. 23-80). São Paulo: Contexto.

Wilches-Chaux, G. (1993). La vulnerabilidad global. In A. Maskrey (Org.), Los desastres no son naturales (pp. 9-50). Bogotá: Tercer Mundo Editores.

Zamparoni, C. A. (2011). Mudanças Climáticas, Riscos e Desastres Naturais em Ambientes Urbanos. In G. F. Seabra (Org.), Educação Ambiental no Mundo Globalizado: Uma ecologia de riscos, desafios e resistências (pp. 159-170). João Pessoa: EdUFPB.