Coding disasters: an open tool for managing municipal drainage network in risk areas

L. T. S. Azevedo, M.Sc.[1*], J. Caprario, M.Sc.[1], T. M. Tsuji, M.Sc.[1,] P.L. Santana[1], R. R. Higashi, Ph.D.[2], A. R. Finotti, Ph.D.[1]

[1]LAUTEC – Urban Stormwater and Compensatory Techniques Laboratory, Federal University of Santa Catarina, Delfino Conti Street, s/n – Trindade, 88040-900 Florianópolis – SC, Brazil

[2]LAMGEO - Geotechnical Mapping Laboratory, Federal University of Santa Catarina, João Pio Duarte da Silva Street – Córrego Grande, 88040-900 Florianópolis – SC, Brazil

**Corresponding author email: larissathainaa@gmail.com*

Highlights

- We developed a code to automatize the process of geoprocessing disasters occurrences.
- We integrate Matlab code with API, geoprocessing software, and municipal database to prioritize stormwater infrastructure demands.
- Our open tool provides low-cost and easy application for any Civil Defense Agency.

Introduction

The hydrological disasters risk management reflects in the public stormwater network infrastructures and vice versa. The availability of data, constant updating, and dissemination of information must be consistent and effective. Smart-city management means the intimate relationship between civil rights, connectivity, and technology. When associated with sustainability, it acquires strategic value, understanding the risk scenario and speed of response (Marchezini and Wisner, 2018; Miguez, Di Gregorio and Veról, 2018; Lantada, Carreño and Jaramillo, 2020). The non-linear and precarious relationship between databases analyzes and updates of new cases can be improved, optimizing the results. In many countries, such as Brazil, municipal decision-makers face difficulties organizing budgets and prioritizing demands because of the unavailability of credible management tools. These happen when the methodology employed, such as PMRR - Municipal Risk Reduction Plan (Brazilian Federal Law No. 12.608 / 2012), prolongs for years while new risk occurrences change the reality. The PMRR states three levels of risk: R1 – less critical condition; R2 - destabilization process at an early stage of development; R3 – complete state of destabilization with still possible monitorable solutions; and R4 – impossible to monitoring, high risk of constant landslides and mass movement. Therefore, the main goal of the present work was to develop an open code to automatize the decision-making process relative to listing the priority areas in need of urban drainage infrastructure (and repairs) using the data of the Municipal Civil Defense department and the PMRR. The strategy is to connect the steps within the field survey and the decision-making process through an open code and geoprocessing software.

Methodology

The study was conducted in Florianópolis city, located in the southern region of Brazil. It is a municipality with two very different areas: the continental and the island. The central region of the island is occupied by informal settlements and native nature along the hillside of the rock formation, the Morro da Cruz Massif. The applied methodology was: a) data collection and selection; b) development of open code in

Matlab language; c) identification of priority areas by simple statistical analysis in a geoprocessing software superimposed on the PMRR and d) correlation between the areas of worst cases with the photographic records of the occurrences, meaning an easy-understandable framework decision-making. The methodological process applied is presented in Figure 1.

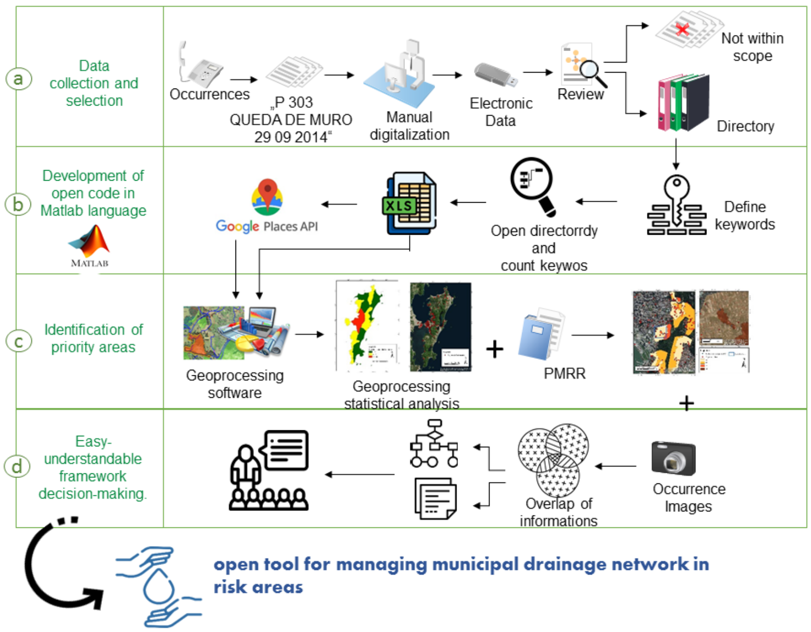

Figure 1. Methodological process.

The Matlab code developed accesses the case file directory, identifying the .doc file by its standardized name "P n ° of occurrence in the year Type of occurrence/name of applicant date", for example: "P 303 QUEDA DE MURO 29 09 2014" that means "P 303 WALL FALL 29th April 2014". The code identifies the .doc document and the type of the occurrence and, if there are keywords, it generates a line in the database spreadsheet. The code recognizes a folder that contains the files by year, month, and protocol and identifies the keywords in the document. Keywords are identified by comparison between counting the number of words present in the occurrence form template with counting extra words. The code identifies the words present in "Occurrence / History" and "Observations". The product is an Excel spreadsheet with the applicant's name (name of the protocol and, consequently, name of the directory where the field form is located), date of entry of the occurrence, address, neighborhood, and the keywords found. The keywords are determined according to different types of disasters, e.g., risk area, landslides, rock and wall falls, minor mass movement, debris, and mudflow. Through the Google Maps Application Interface (API), the addresses in the spreadsheet are converted in georeferenced coordinates in a KML file, exportable to geoprocessing software. Risk maps are then generated and crossed with the coordinates of disasters superposed with the previous PMRR. The overlap of data highlights the main critical area with drainage problems. The code considers the current Civil Defense logistics, to facilitate the agents' work, but not generating any additional cost.

Results and discussion

It is expected that the agents pay even more attention to the correct filling of the forms, valuing the management of data when they see the possible results that can be achieved by using the open code and the API. The intersection of the spatialization of records with official documents and photographic analysis proves the direct relationship between the disasters in Florianópolis and the poor management of stormwater drainage infrastructures, leading to the urgency to address practical improvements beyond the theoretical PMRR. As an example, there is the Morro da Mariquinha region (Figure 2), an informal settlement in the central region of the island. The situation of the natural stream that runs through the community is alarming. There is a large volume of solid waste and apparent rocks, dense vegetation, and construction on the banks. On rainy days, the stream that barely appears in the figure turns into a waterfall. The residents' demand is for concrete galleries that take the waters of the stream away. Although the demands were already listed in the PMRR, and the region is classified with 3 different levels of risk, the community still owns the most occurrences of the Civil Defense and lives with fear.

Figure 2. Morro da Mariquinha: 2 occurrences in level 3 risk: a high-risk region with an intermittent stream as water supply.

Conclusions and future work

Data organization is essential for efficient risk management. Equally necessary is knowledge management, i.e., the data used in the survey is from 2012 onwards; there is no previous data available, which compromises statistical analyses. Losing data is a common practice for municipal agencies with changes of government. However, disasters are external to these changes, and therefore disaster risk management must be long-term planned. The association of field survey, Matlab code, API, and geoprocessing enables more practical and cleverer applications of the PMRR and the municipal budget. Furthermore, the open tool for coding disasters can serve as a decision-making phase for the allocation of new technologies in urban stormwater, such as SUDS, in informal settlements located in risk areas, where poverty aggravates the risk of disaster with poor runoff management. This easy-to-understand decision-making framework is advantageous for community meetings where information must be accessible and pragmatically presented.

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