

METHODOLOGY FOR VULNERABILITY MAPPING OF THE TERRITORY AGAINST THE RISK OF FLOOD RELATED TO ASSISTANCE SYSTEMS. APPLICATION TO BAJO GUADALHORCE FLOOD AREA

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1. INTRODUCTION

The concept of vulnerability to risk and derived cartography has had, since its origin, problems of conceptualization. Emerged within the framework of radical geography, the concept emerges as equivalent to a situation of socioeconomic precariousness that explains inequality in the face of catastrophe. From this initial notion, described and defined more in the theoretical than in the applied, there have been many contributions to the concept that have been produced from very different fields and perspectives (sociological, economic, etc.). As a result of the diversity of approaches, there has been a conceptual dispersion in the notion of vulnerability to risk (Perles *et al.*, 2015), which has inevitably resulted in imprecision and lack of consensus in the applied phase.

Human participation in the genesis of risk is articulated through the concepts of induction, exposure and vulnerability, and more recently, in the concept of resilience. The role of the territorial pattern of human uses is gaining prominence as a factor causing risk, and also as a key in the search for solutions

One of the key elements to define the vulnerability to the flood at the time of crisis is the presence and effectiveness of relief systems and assistance to the population potentially in need.

This article proposes a concrete methodology for the evaluation of the relief and assistance systems, simulating their arrival times to the flood zones under two very different conditions, on the one hand, conditions of normality (without flood phenomena) and on the other hand part under the adverse effects of floods, which makes it possible to delimit the areas of greatest vulnerability to flooding in terms of relief systems and assistance.

2. THEORETICAL AND NORMATIVE BACKGROUND.VULNERABILITY AGAINST RISK

The methodology developed in this work, and the cartographic results obtained through it, is inserted in a broader line of research in which the concretion of a cartographic catalog for the systematic evaluation of vulnerability to the flood is proposed (Perles *et al.*, 2017). The cartographic catalog of vulnerability to flooding has been conceived as a set of cartographic documents useful for the resolution of the problems of vulnerability to flooding that serve as a support tool for the application of the mitigation measures indicated in the Plans of Flood Risk Management, to be applied through the Local Area Action Plans. A catalog of maps structured according to specific vulnerability problems previously inventoried in the analysis of flood events and previous crises has been designed.

The cartographic documents of the catalog are intended to offer specific information to solve

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specific problems related to vulnerability to flooding. Therefore, the main problems that occur in crisis situations have been identified:

- Problems related to vulnerability to danger:

1. Interruption of basic territorial services
2. Isolation of the population
3. Distress and assistance difficulties
4. Risky or unsafe behavior of the population
5. Affection of particularly sensitive goods or sectors of the territory
6. Affection of elements of the territory due to pollution and other risks associated with flooding

- Problems related to vulnerability to loss and resilience:

7. Generation of large losses
8. Difficulty of the population for recovery after the impact

3. OBJECTIVES

The main objective of this article is to describe the indicators and methodological steps necessary to prepare a flood vulnerability map based on the assistance needs of the exposed elements (population and goods) during the crisis phase (rescue, assistance, vigilance) and the effectiveness with which the relief services serve the population potentially in need during the disaster.

The final objective of this cartographic tool is to help entities and organizations that are competent in decision-making to identify the areas that are most likely to be unassisted in times of crisis, therefore, those most in need of priority actions. The cartography obtained thus contributes to improving the resilience of an area with chronic flooding, and can be implemented in the Local Level Action Plans on Potential Significant Risk Areas.

4. STUDY AREA

The study area is located in the Bajo Guadalhorce area, the municipalities that comprise it are Málaga, Alhaurín de la Torre and Torremolinos. The choice of this study area is related to a history of historical floods of great intensity, an area of high danger, in which the flood manifests itself with a chronic character, the last episode being very prominent in the 1989 event. an area of expansion of the city of Malaga, with a marked peri-urban character that presents morphological and functional characteristics that distinguish the production of risk (Perles and Mérida, 2009).

5. METHODOLOGY

The methodology addresses how to achieve a simulation of response times (isochronous maps or time of arrival) of the relief and assistance systems (firefighters) and how floods should be treated so that network analysis models can incorporate the road cuts and therefore accessibility of these means to the areas affected by the flood. This methodology proposes the spatial databases and methodological steps, which must be applied in order to generate a network analysis that adjusts as best as possible to the reality of the flood phenomenon and its interaction with accessibility. The methodology is generated to be applied when phenomenon of flood that affects the territorial functionality by cuts of communication routes, both main and secondary, are produced. For this the methodology establishes an initial analysis, where the contour model conditions have not got territorial flood affections, and also in a different situation, where the contour conditions have already changed by flood effects, generating cuts of roads and problems of accessibility. The final objective of the methodology is to establish a

METHODOLOGY FOR VULNERABILITY MAPPING OF THE TERRITORY AGAINST THE RISK OF FLOOD RELATED TO ASSISTANCE SYSTEMS...

comparative analysis between the situation without floods and later with floods, and to see how vulnerability of the human environment to flood, and linked assistance systems, are affected.

Summary of the methodological steps developed:

- Information about firemen's agents who provide relief and assistance.
 - Digitalization of the road network
 - Obtaining barriers or inaccessibility zones for the different types of relief and assistance agents
 - Obtaining barriers or inaccessibility zones for the different types of relief and assistance agents
 - Obtaining barriers or inaccessibility zones for the different types of relief and assistance agents:
- Analysis of networks without barriers (without flood phenomenon)
-Analysis of networks with barriers and cost increases due to flood phenomenon
-Comparison between different network analysis.

6. RESULTS

FIGURE 1

Cartography of access and response time of fire fighter agents assistance, in normal conditions

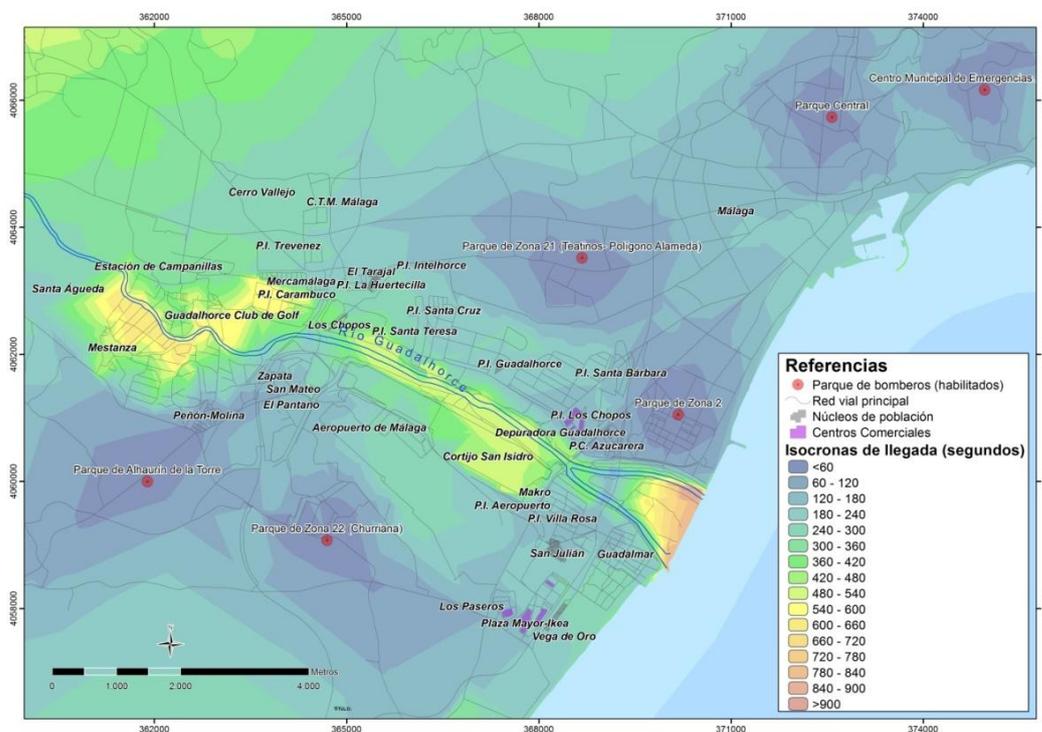


FIGURE 2
Cartography of access and response time of fire fighter agents assistance, with flooding blocking or insulation situation

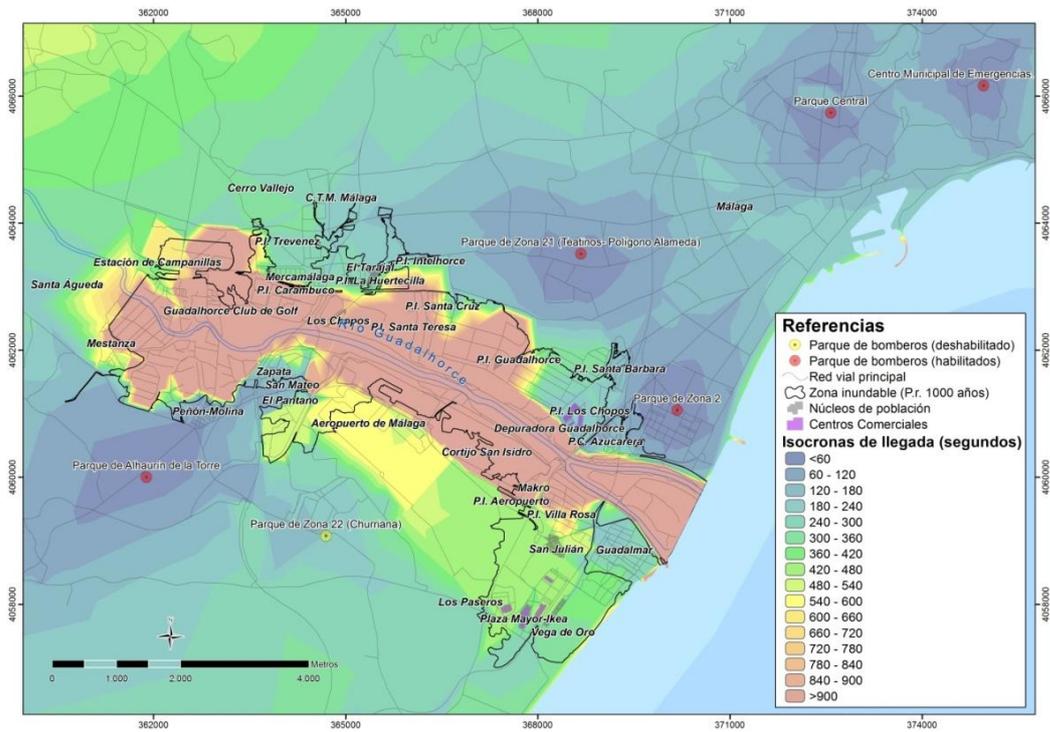
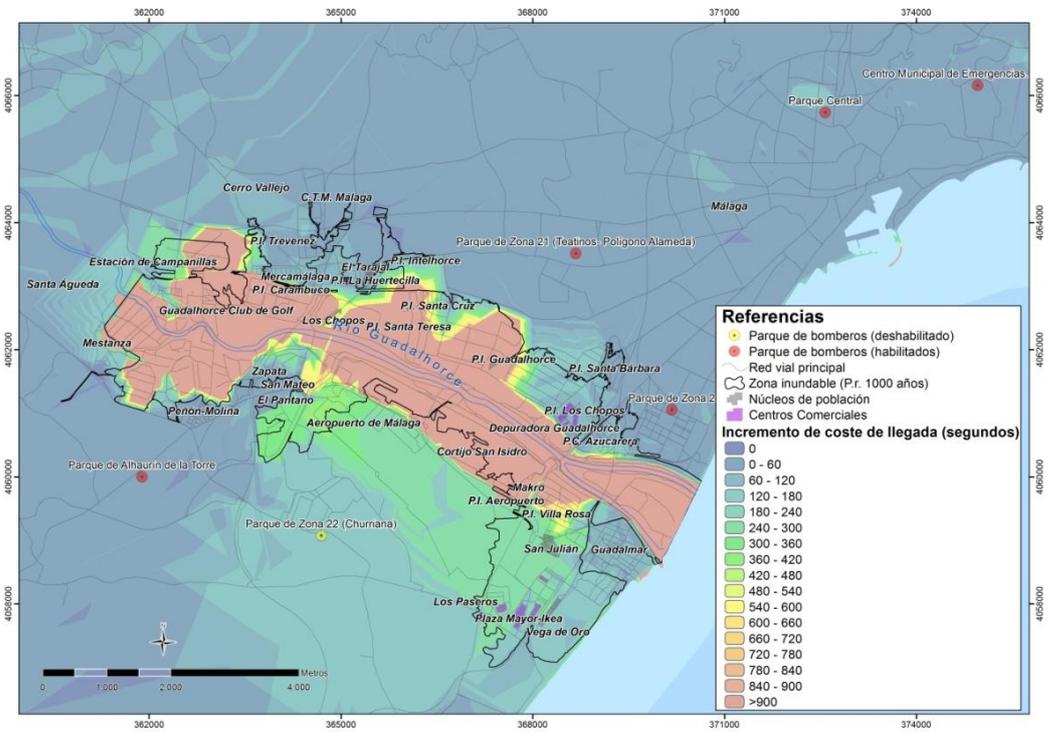


FIGURE 3
Resultant comparative cartography, cost time increases and final blocks of fire fighter agents assistance



7. CONCLUSIONS

The proposed methodology is a direct contribution to the applicability of risk studies at the local level. The ability to zonify and establish which areas are more isolated or unassisted at the territorial level, provides a tool of vital importance, both for the development of territorial ordering and to develop better Local Action Plans by the competent entities. The methodology is applicable to other assistance agents, and suggests various ways of progress and exploitation. For instance, could be used to obtain more direct results, such as the more precise identification of the sectors of the territory that are most likely to need assistance (more vulnerable), in order to prioritize the most necessary routes, and to be able to guarantee their functionality during the crisis.

Conceptually, the methodological contribution, considering the vulnerability of the relief systems as a dependent variable of the dangerous conditions, incorporates as a novelty the effective linkage of the hazard (draft), and the vulnerability (effectiveness of the distress system), components of risk that are usually assessed in an additive manner, but not necessarily interrelated.

8. BIBLIOGRAPHY

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