



Proceeding Paper

Field Campaign for the Collection of Exposure Data Regarding Natural Hazards in Heritage Buildings, Guaranda, Ecuador [†]

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Abstract: The present investigation addresses the context in which the heritage buildings of the city of Guaranda (Ecuador) are exposed, in the face of natural or anthropic hazards. The interest lies in the degree of sensitivity towards the correct assessment of cultural heritage, given that, for several years, this issue has been scarcely analyzed or documented. Consequently, field work was carried out in conjunction with the authorities of Guaranda and the Bolívar State University, in order to update the inventory of goods. The exposure and vulnerability measures of the National Institute of Cultural Heritage were used to analyze hazards and vulnerabilities in a GIS environment.

Keywords: hazards; risks; heritage; technology; GIS



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1. Introduction

Ecuador is a Latin American country that stands out for its natural, cultural, and patrimonial wealth. Its legacy includes hundreds of archaeological remains, works of art, heritage buildings, traditions, and customs, which reveal the history and identity of its inhabitants.

In fact, in the country, there are 180,000 inventoried heritage assets, 18 intangible heritage items, and 38 cities declared as part of the Cultural Heritage, located in the Sierra, Costa, and Amazonia regions. In addition, approximately 30% of the Ecuadorian population resides in patrimonial houses [1].

From the pre-Columbian stage to contemporary times, the history of Ecuador has been built on a difficult geographical location, determined by the Pacific ring of fire, and challenging hydrological and geomorphological characteristics and climatic conditions. These have constantly exposed it to the occurrence of adverse events such as earthquakes, landslides, floods, fires, and volcanic eruptions, putting the Ecuadorian society, environment, infrastructure, and heritage at risk.

The study area, Guaranda, is one of the Cultural Heritage cities and is located in the center of the inter-Andean region of Ecuador. The buildings located in the historic center date from 1802 onwards, but unfortunately, since that time, and despite having a heritage inventory, few or no actions have been taken in terms of the protection and conservation of heritage assets, due to the neglect of the authorities and some of the owners [2].

In addition, Paredes et al. [3] describe with great concern the accelerated loss of the built heritage of the city of Guaranda due to several causes, including natural phenomena, a lack of management from the responsible authorities, the scarce proposals for projects, and the limited possibility of interventions by owners, since maintenance costs are very high.

Given the cultural importance of heritage buildings and their continuous exposure to natural hazards, it is necessary to update the inventory of the cultural heritage of Guaranda and reassess the vulnerability of these buildings to quantify their associated risk.

2. Materials and Methods

The development of this research has a descriptive methodological structure and a field design with a quantitative and qualitative approach, which responds to the correct updating of the inventory of heritage assets using the indicators of the National Institute of Cultural Heritage (INPC).

The technical–scientific link between the Decentralized Autonomous Government of the Guaranda Canton (GADCG), the Universidad Estatal de Bolívar (UEB), and the Universidad Politécnica de Madrid (UPM) is considered, in order to update the existing data and improve the quality of information in public databases.

The methodology contemplates three fundamental phases, which are shown in Figure 1 and are described below:

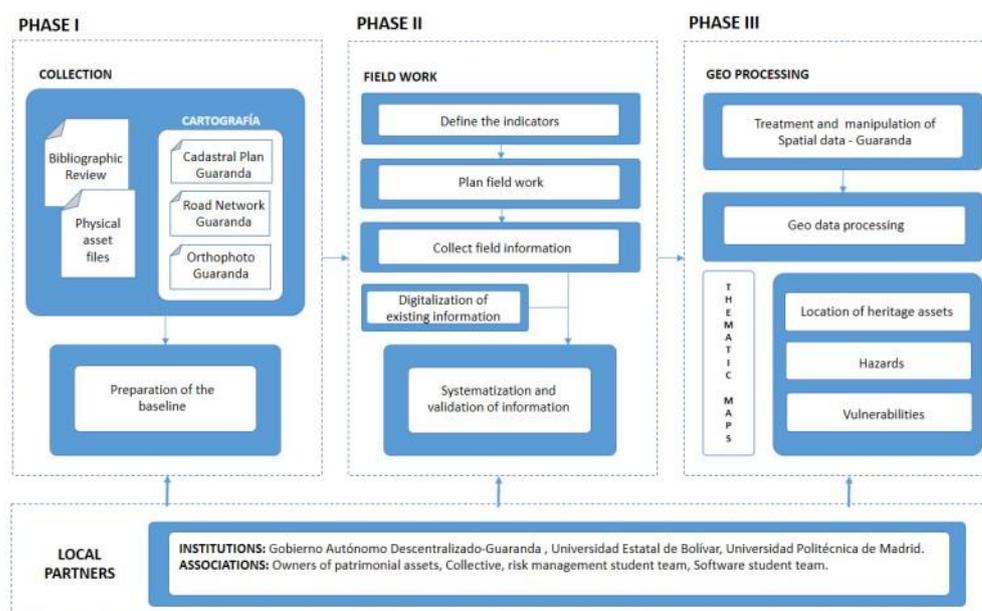


Figure 1. Proposed methodology.

2.1. Phase I, Collection

First, we identified, registered, and took an inventory of the real estate belonging to the cultural heritage of the Guaranda Canton. The existing information regarding the patrimonial buildings from the year 1997, which could be found in the Department of Planning of the Decentralized Autonomous Government of the Guaranda Canton, was considered. Second, an exhaustive literature review was carried out. This provided a baseline for the data collected for this research.

2.2. Phase II, Fieldwork

This stage took place over 14 weeks. The first part consisted of defining the indicators to be updated, for each exposed building, under the criteria of the National Institute of Cultural Heritage (See Table 1). In parallel, the basic information for each file inventoried was digitized and integrated into the GIS and related geodatabase.

The planning of the field work included activities such as the design of the data collection instrument with the help of Kobotoolbox version 2022.4.4, developed by the Harvard Humanitarian Initiative, located in Cambridge, MA, United States Massachusetts, which allows the registration of the geographical location of the study elements, even without an internet connection.

Then, a team of 30 students from the Universidad Estatal de Bolívar was trained and instructed in the use of the Kobotoolbox tool to analyze the data collection criteria, to consolidate the knowledge about some architectural terms and to establish the guidelines for risk analysis in buildings.

Table 1. Indicators—heritage buildings.

Indicators	Description
General data	Owner’s name, house number, tenure, habitability
Localization	Province, canton, city, parish, streets, and geographic coordinates
Property regime	State, military, municipal, religious, private, other
Applications	Original/current
Basic services	Drinking water, electricity, telephony, internet service, number of meters
Floors	Numerology
Mobility	Garage and vehicular access
Threats	Earthquakes, mass removals, floods, eruptions, ash fall, fires, subsidence
Vulnerabilities	Physical, economic, social, political, cultural, others
Post-inventory interventions, 1997	Foundations, floors, mezzanines, ceilings, structure, walls, partitions, roofs, installations, others
Current building conditions	Railings, installations, mezzanines, foundations, stairs, floors, walls, partitions, portals, arcades, galleries, balconies, doors, windows, structure, flat/low ceiling, roof
Additional constructions	Yes/no, current use, year of construction, construction area, permit number, photograph
Photographs	Right-side facade, front façade, and left-side facade.

Likewise, a meeting was held with the owners of the heritage assets in the municipal hall of the Decentralized Autonomous Government of Guaranda Canton, in order to socialize the objectives of the project and to encourage a commitment to the delivery of information.

In view of having an adequate opening from all the social actors, the information was collected in the field over 4 weeks, with 3-hour days. This activity included the visit to the owners, the application of the surveys, and the external and internal inspection of the patrimonial assets.

Finally, the information collected was systematized and validated within the geo-referenced database of the Kobotoolbox tool and was processed and tabulated through statistical analysis.

2.3. Phase III, Geoprocessing

At this stage, the treatment and manipulation of the spatial data obtained in the first and second phase of the investigation were carried out.

Within the ArcGIS Pro environment, version 2.8.0, developed by ESRI company, located in southern California, the necessary cartography of Guaranda was added, together with the information collected from the buildings, in order to generate thematic maps of their locations, threats faced, and vulnerabilities.

3. Results

- During the first phase, it was possible to identify, register, and take an inventory of 100% of the information, corresponding to 114 heritage buildings from the year 1997. This allowed the preparation of a baseline with a set of evidence on the initial situation, such as old photographs, architectural typology, drawn locations, and files in physical format from the National Institute of Cultural Heritage.
- During the second phase, it was possible to quantify and qualify 100% of the real estate belonging to the cultural heritage of Guaranda Canton. This allowed us to characterize the current state of the buildings.

- During the third stage, it was possible to generate 100% of the thematic maps (see Figure 2). This set of maps facilitated: (a) the geographical location of Guaranda, (b) the location of patrimonial goods, (c) the identification of recurring hazards facing the heritage buildings, mainly earthquakes, followed by fires, ashes falling, and sinking. With respect (d) to vulnerabilities, the highest percentage corresponds to physical vulnerability, followed by economic, political, real-estate, and family vulnerabilities.

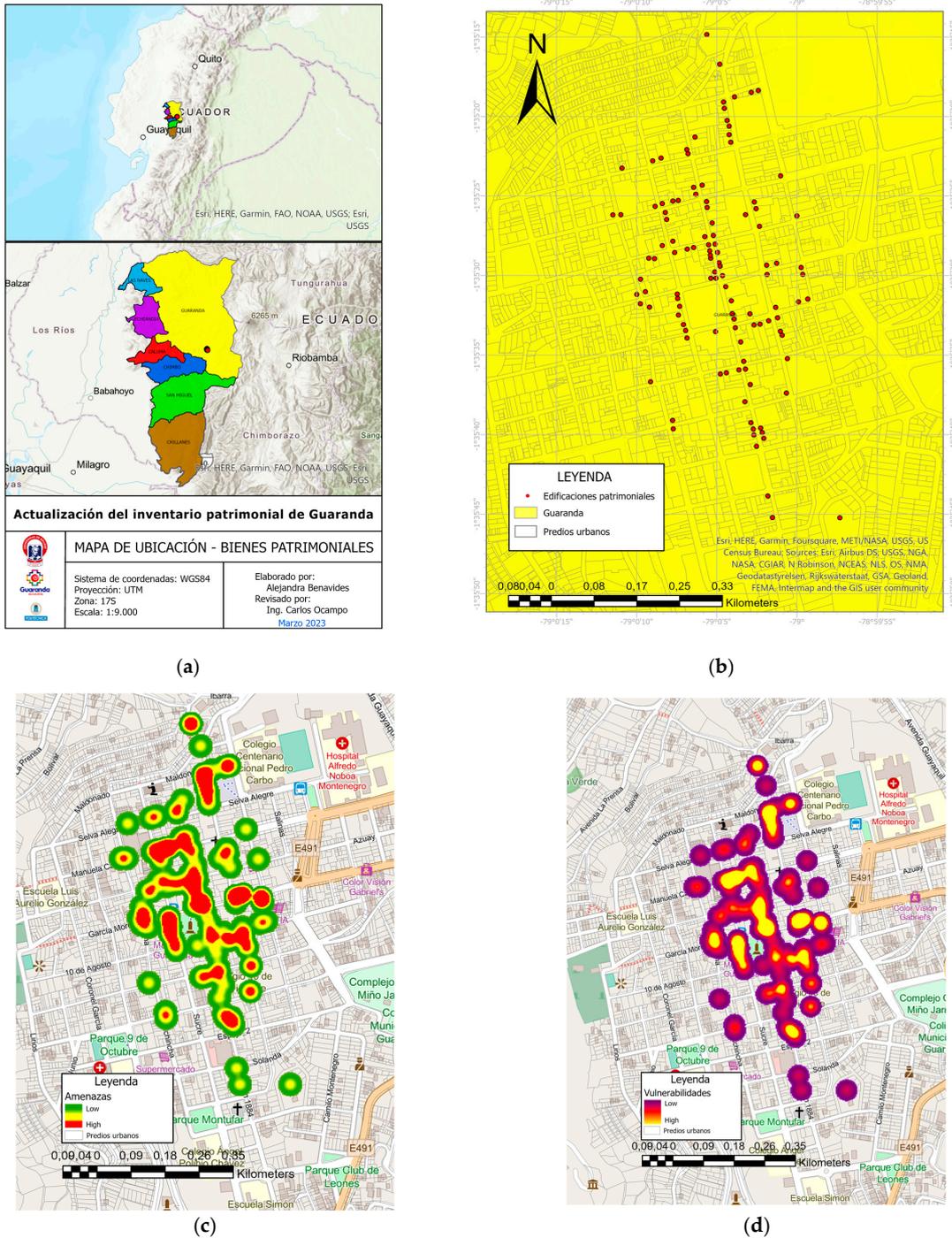


Figure 2. Thematic maps of the location of Guaranda (a), patrimonial goods (b), hazard (c), vulnerabilities (d).

4. Discussion and Conclusions

1. The main objective of compiling a database of the characteristics, exposure, and vulnerabilities of heritage buildings in the city of Guaranda has been met.
2. Greater vulnerabilities in the buildings have been identified and show the urgent need to carry out projects and programs and promote policies that allow us to save the historical traces of Guaranda.
3. The social and institutional link has been consolidated, allowing us to continue the participation and commitment to the feasibility of the research project, based on the protection and conservation of heritage assets.

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Conflicts of Interest: The authors declare no conflict of interest.

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