Urban policies during the last four decades have influenced the risk of flooding in Cartagena (Spain): A retrospective spatial analysis.

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ABSTRACT

In the last five years, three important floods have caused considerable damage in Cartagena, a city located on the southeastern Mediterranean coast of Spain. Even though the city has suffered from flooding throughout history, its current Municipal General Urban Development Masterplan, approved in 1987 and subsequently modified 82 times, has not sufficiently prevented land occupation of flood-prone areas. When reviewing the urban policies of the last four decades, an evaluation using GIS-based indicators and geostatistical analysis shows that the urban flooding vulnerability level is too high in urban areas in which it is currently exceedingly difficult to solve the problems created.

THE CASE STUDY IN CARTAGENA

The city of Cartagena, on the southeastern Mediterranean coast of Spain (Figure 1), characterized by a scarce annual mean precipitation of around 220 mm -most of which falls during storm events in autumn- has suffered from flooding throughout history. In the last five years, this city, with a population of over 200,000 inhabitants, has experienced three important floods derived from the DANA phenomenon (Spanish acronym for Depresión Aislada en Niveles Altos, meaning upper-level isolated atmospheric depression), like a cold drop, but which causes much more intense torrential rains.

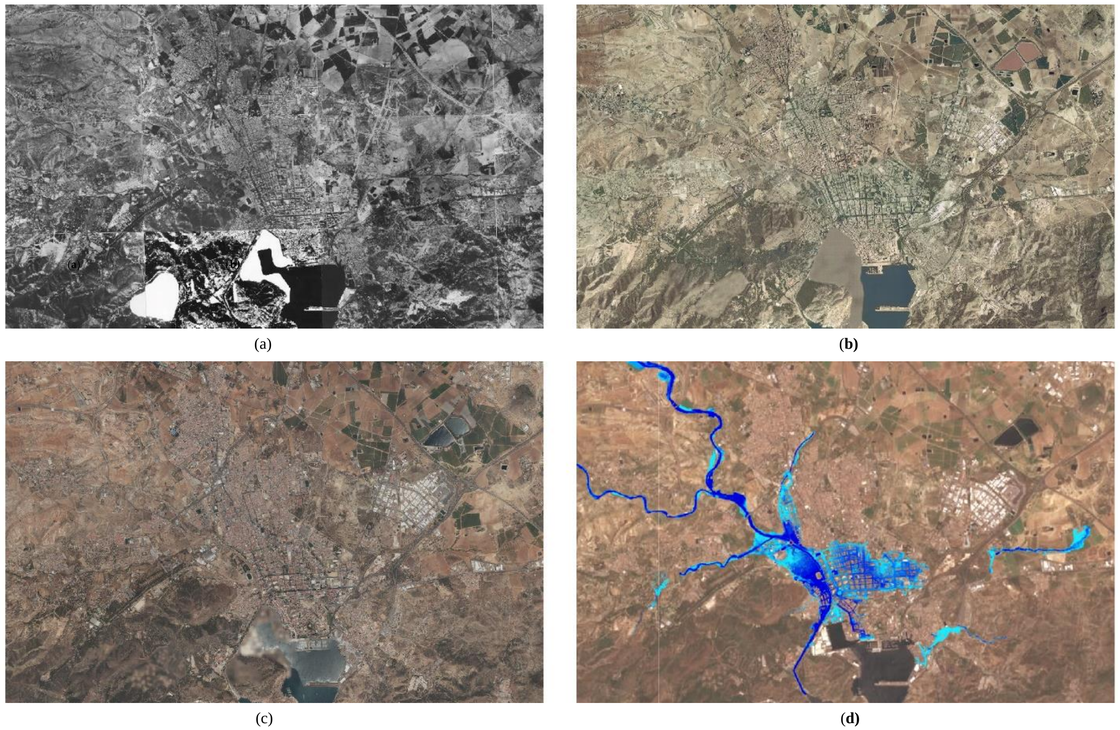
The Municipal General Urban Development Masterplan (MGUDM) currently in force was approved in 1987. It has not prevented land occupation of flood-prone areas. Since then, 82 modifications of the Masterplan have been approved, but little has been contem-plated in these four decades from the perspective of vulnerability to flooding risk, without consider the disadvantages and challenges of building in flood-prone zones.

A new Masterplan is currently being developed and should incorporate several flood risk mitigation measures based on guidelines of regulations and plans at both national and regional scale, such as the Land Law, the Murcia Region Urban Code, the Murcia Re-gion Civil Protection Plan Against Flood Risk, or the Regulation of Public Hydraulic Do-main (RPHD), especially in the Preferential Flow Zone delimited by the Segura Hydro-graphic Confederation (SHC).

Figure 1. Case study. City of Cartagena, on the southeastern Mediterranean coast of Spain.

RESULTS AND DISCUSSION

The urban development of Cartagena in the last four decades (Figure 3) has been carried out, as in previous decades, in flood-prone areas with risk for the population, delimitated according to the cartography of floodable areas for a 500-year return period, as indicated by the recently amended RPHD. Therefore, the current MGUDM, approved in 1987, has not served to prevent the further construction in floodable areas. As a result, the flooding risk level is currently too high in different areas of the city, showing how inadequate urban policies can contribute to the increase in the risk of flooding in urban areas [3,4].



(a) (b) (c) (d)

Figure 2. Evolution of urban growth during the last four decades in the city of Cartagena: (a) orthophoto of the city of Cartagena in 1981; (b) in 1999; (c) in 2019; and (d) map of flood-prone areas with risk for the population in urban areas with the return period of 500 years. Source: [5].

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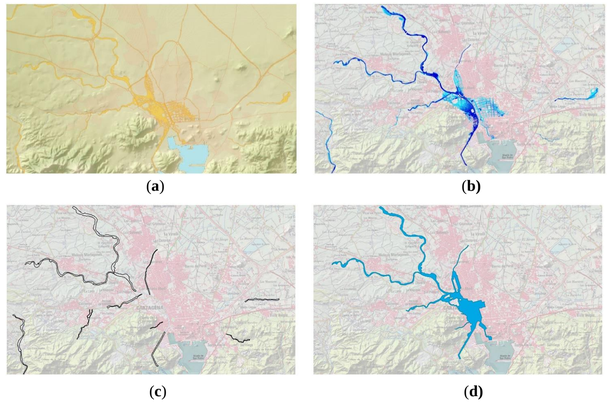
Areas planned as buildable land in the current MGUDM, which are planned to be urban-ized in the coming years, are in FPZ (Figure 4) delimited according to the criteria of the re-cently in force RPHD (although the cartography, currently in the public information peri-od, is pending approval). These criteria are more restrictive in terms of building authori-zation, considering areas with risk for the population, where serious damage to persons and property may occur, not only the floodable area for 100-year return period, but also orographic conditions of the terrain (when hydraulic conditions during the flood meet one or more of the following criteria: drafts > 1 m, speed of water > 1 m/s, product of both > 0.5 m2/s). Therefore, it would be highly advisable for the new MGUDM, currently under prep-aration, to take into account not only the current situation of the city flood vulnerability, but also to go further, taking into account the foreseeable consequences of climate change [1], including the increase in the number and intensity of torrential rains and DANAs in the Mediterranean area, to avoid future problems that will be very difficult to solve.



(a) (b) (c) (d)

Figure 3. Implementation of spatial information on flood-prone areas: (a) terrain elevation model incorporating orographic conditions in areas at risk of flooding; (b) flood risk map for a 100-year return period; (c) current preferential flow areas and (d) preferential flow areas for public consultation pending approval. Source: [5].

METHODOLOGY

GIS-based multivariate indicators of urban and territorial transformation

The indicators selected to evaluate urban and territorial transformation are: Index of Soil Artificialization (SA), Indicator of Infrastructural Anthropization (IFA), Index of City Compactness (ICC), and Flood Zone Index (FZI). The methods of calculating these indica-tors are detailed by García-Ayllón and Franco [3,4].

To analyse flooding spatial data, the return period of 500 years from the Spanish Na-tional Flood Mapping System geoportal website [5] has been used. This value has been chosen in accordance with Royal Decree 665/2023 which has recently amended the RPHD. It is the one which currently has more urban planning implications in the regula-tions to obtain urbanization authorizations. Likewise, in accordance with said Decree, preferential flow zones (PFZ) are delimited, on the flood risk maps for a 100-year return period [5], considering the orographic conditions to prioritize the level of danger.