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Natural hazards in the Regional Land Management Plans of the province of Malaga (Spain). Suggested improvements

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In recent years, Europe has been changing the paradigm in the management of natural hazards. Engineering works and 'post-disaster' solutions must be replaced by preventive measures (Vargas & Cánovas, 2022; Górgolas, 2020). Among the preventive measures, land use planning is the most cost-effective and effective option. This idea has been adopted by administrations, but we now face a double problem: on the one hand, the way in which natural hazards are managed in land use planning has the mismatches that are typical of policies that are still relatively recent in legal order. On the other hand, the scale used is usually that of development planning (urban sectors) or, at best, that of general planning (municipal terms). However, natural hazards, like any ecosystemic process, are composed of a complex network of environmental and territorial connections and correlations that require analysis at a smaller scale. Regional or local scales allow for more efficient action than if we only consider a specific space with a certain level of danger (Olcina, et. al., 2018; Olcina, 2010).

Under the above premise, the objective of this paper is to analyze how comarcal land use planning in the province of Malaga incorporates and regulates natural hazards in territorial policies, as well as to establish proposals for improvement in this regard.

The methodology consisted of analyzing how natural hazards are included in subregional land use planning in the province of Malaga. To do this, a series of important items for incorporating natural hazards into subregional plans were worked with. These items were applied to both the current plans and those in the process of being drafted. These plans are:

- Eastern Costa del Sol-Axarquía POTS, in force since 2006
- Malaga Urban Agglomeration POTS, in force since 2009
- Western Costa del Sol POTS, in drafting
- Serranía de Ronda POTS, in drafting



The analyzed items were as follows:

1. Are the natural hazards affecting the territorial scope of the POTS identified in the document? What studies support these risks?
2. Is natural risk cartography incorporated into the Plan? Is this cartography included in the zoning plans?
3. Are use limitations established in the planning of the territorial scopes affected by natural hazards?
4. Are preventive proposals included for the identified natural hazards?
5. Are corrective proposals included for the identified natural hazards?

This information has been evaluated both in the informative documents (information and planning reports) and in the prescriptive ones (economic, normative, and cartography reports). The effective use of natural risk cartography and its incorporation into the proposed planning has been considered of particular interest. For cartography, the collected cartographic variables, sources used, type of cartography (hazard/risk), scale, and its incorporation into the planning were verified.

The results obtained have been synthesized in the following scheme (table 1):

Table 1. Schematic summary of the items analyzed in each POTS.

| POTS | Costa del Sol Oriental-Axarquía | Aglomeración Urbana de Málaga | Costa del Sol Occidental | Serranía de Ronda |
|--------------------|--|--|---|--|
| Term of the plan | In force since 2006 | In force since 2009 | In writing | In writing |
| Formulation decree | Decree 147/2006 | Decree 308/2009 | Decree 143/2017 | Decree 180/2021 |
| Item 1 | Yes, although with insufficient technical or methodological precision | | | |
| Item 2.1 | IM: potential erosion, slope instability, flooding and coastal erosion SPC: flood precautionary zones and areas of high slopes | IM: slopes, sections with floodability, lithologies SPC: HPD | IM: seismic hazard, HPD, flood zone for 500 years | IM: risk of gravitational movements, expansive soils, potential erosion, floodability for 500 years, ARPSIs, forest fires |
| Item 2.2 | Only partially (flood protection zones and areas of high slopes) | No, only HPD is included | At the present stage there is still no management mapping | At the present stage there is still no management mapping |
| Item 3 | It is indicated that the municipality will be zoned according to the type and dangerousness of the risk; Precautionary flood zones are collected | It is indicated that the municipality will be zoned according to the type and danger of the risk | It is indicated that the municipality will be zoned according to the type and danger of the risk, flood precautionary zones are collected and a fire protection perimeter is proposed in the urban-forest interface | No |



| POTS | Costa del Sol Oriental-Axarquía | Aglomeración Urbana de Málaga | Costa del Sol Occidental | Serranía de Ronda |
|---------------|---|---|---|-------------------|
| Item 4 | It is proposed to carry out studies of the physical environment and preventive measures only for the phases of work; The comprehensive analysis of river basins is proposed | It is proposed to carry out studies of the physical environment and preventive measures only for the phases of work; comprehensive river basin analysis is proposed; Hydrological-forest restoration actions are proposed | The comprehensive analysis of river basins is proposed; hydrological-forest restoration actions are proposed; Other preventive proposals are indicated for their realization by other administrations | No |
| Item 5 | Corrective proposals for flooding are indicated for implementation by other administrations; Recommendations are made for specific channels | An investment program is established to correct bottlenecks in channels | No | No |

Item 1: Are natural hazards that affect the territorial scope of the POT identified in the document?; **Item 2.1:** Is natural risk cartography incorporated into the Plan?; **Item 2.2:** Is such cartography included in the ordination plans?; **Item 3:** Are usage limitations established in the ordination of territorial areas affected by natural hazards?; **Item 4:** Are preventive proposals included for identified natural hazards?; **Item 5:** Are corrective proposals included for identified natural hazards?; **IM:** Informational Memo; **SPC:** Spatial planning cartography.
Source: authors' own.

After analyzing each of the plans, a series of common conclusions can be drawn. In general, there is a real concern about the high impact of natural hazards in the province of Malaga, but this concern appears mainly in the informational memos, without being effectively translated into the normative memos, final cartography, or ordination. Additionally, when they are incorporated into the normative text, they are mostly done as 'guidelines' and 'recommendations,' which, in practical terms, means that they are not ultimately included in the general planning, much less the development planning. Some of these guidelines could and should be incorporated as 'rules' to make their compliance binding. In addition to this main idea, other more specific conclusions can be drawn, such as:

- Plans typically limit themselves to using existing sectorial regulations, without conducting specific studies for each plan's specific issues. The comarcal scale is the most suitable for analyzing and preventing natural hazards, so an excellent opportunity is lost if these plans are not used to make specific analyses and proposals.
- Some plans indicate that municipalities must be zoned according to existing natural hazards, but it would be more appropriate to carry out this zoning within the Plan itself. Additionally, it is not indicated how this zoning should be carried out methodologically, nor the legal specificities that must be met.
- There are technical and methodological shortcomings in the analysis of natural hazards. Generally, generalities are used with insufficient technical rigor. Rarely are bibliographic references to the studies on which they are based, variables, scales, or methodological information included.
- There is a lack of coordination between administrations. An example is the use of the national soil erosion map in the Serrania de Ronda's POTS instead of using the provincial potential soil erosion cartography available from the Provincial Council, which is more recent and of a more appropriate scale.
- There are no references to vulnerability or exposure.



- Generally, only the risk of flooding is worked on, ignoring other important issues such as soil erosion, drought, forest fires, or landslides. These other risks are presented in the informational memo, but they rarely make it to the normative document, and in no case do they make it to the ordination cartography.

In summary, the analysis and management of natural hazards in territorial management is a matter of great importance due to its economic repercussions and even, in some cases, human lives. It is also a field that has been heavily studied in recent years by academic and scientific circles, but real and effective knowledge transfer to territorial ordination and urban planning has not yet been achieved. It is the obligation of universities to guide knowledge towards society's problems, and of administrations to incorporate that knowledge and improve their preventive and management policies. Additionally, for the specific case at hand, with two subregional plans in the drafting phase, these conclusions could be useful in guiding or correcting the way natural hazards are incorporated into territorial ordination.