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Public-Private-Civil Partnership Approach for Improving Disaster Risk Management and Resilience: Application in the Balearic Islands

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ABSTRACT:
In response to the urgent global and European call for climate action, the C2IMPRESS Horizon Europe project addresses critical data and awareness gaps related to compound extreme weather and climate events.
It promotes a shift from hazard-focused approaches to people and place centred strategies for assessing multi-hazard risks, particularly in contexts of weak governance and community vulnerability. Participatory approaches are one possible response and can help strengthen territorial resilience and improve local governance for better risk management in the face of climate change. The Public-Private-Civil Partnership (PPCP) approach, developed by ARTELIA under the C2IMPRESS project in 2023, is part of this dynamic and offers an inclusive model that engages the public and private sectors as well as civil society to address social, economic, and environmental challenges in a coordinated manner.
The PPCP approach was tested through the implementation of Labs at Puigpunyent Municipality (Balearic Islands) for the C2IMPRESS project, contributing to the development of the Municipal Emergency Management Plan, including risk mapping, vulnerability assessment, and disaster response measures. The results can guide future operational situations and protocols within the Plan, incorporating local specificities and moving away from standard plans, thus improving and making disaster risk management and resilience more effective.
The paper contributes to existing research by focusing on multi-organisational perspectives. On a practical level, it supports hospitals in designing their change strategies and processes jointly and in collaboration with other parties that are part of secondary processes.

Keywords: Disaster risk management, Climate change impact, Public-Private-Civil Partnership, Governance, Emergency management Plan, Resilience, Vulnerability, Stakeholders engagement

1. Europe at the heart of climate challenges

According to the Copernicus 2024 World Climate Report (European Centre for Medium-Range Weather Forecasts, 2024), 2024 was marked by unprecedented global temperatures, following on from the remarkable warmth of 2023. It was also the first year in which the average temperature exceeded the pre-industrial level by 1.5°C - a threshold set by the Paris Agreement to significantly reduce the risks and impacts of climate change.

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Numerous global records have been broken, both for greenhouse gas levels and for air and sea surface temperatures, contributing to extreme events including floods, heat waves and wildfires. These data highlight the accelerating impacts of man-made climate change.

Europe and other regions face severe weather events like heatwaves, wildfires, floods, and storms, leading to significant economic losses and fatalities. As the 2023 State of Europe's Climate report and the European Climate Risk Assessment also highlight, the European continent has been warming at twice the global average rate since the 1980s, becoming the fastest-warming continent on Earth. The oceans have also experienced record warmth, with an average annual sea surface temperature of 20.87°C, 0.51°C higher than the 1991-2020 average, according to Copernicus. As for the atmosphere, it has never been so full of water vapour. An "abundance of humidity [which] has amplified the potential for extreme precipitation", Copernicus details. Vulnerable communities are disproportionately affected by these climatic changes.

The increasing frequency and intensity of extreme weather events in recent years underscore the need for strong, EU-wide policies and enhanced disaster risk management capabilities. Consequently, the Union Civil Protection Mechanism (UCPM) has been placing greater emphasis on climate risks and scenario analysis in its operations. In 2023, the European Commission introduced the Disaster Resilience Goals (DRGs) to strengthen preparedness across the EU, Member States, and UCPM participating states for various types of disasters (European Environment Agency, 2024). At the same time, territories are being compelled to adapt and build resilience by developing approaches and strategies tailored to this evolving risk landscape. The Public-Private-Civil Partnership (PPCP) approach provides a framework for facilitating exchanges and synergy between stakeholders, through the tripartite mobilization of the private, public and civil society sectors, in support of a common, co-created vision aiming to improve planning and response to emergencies.

This communication examines the importance of participatory approaches in reducing and managing natural hazards through the implementation of the PPCP approach in Puigpunyent Municipality (Balearic Islands) under the framework of the C2IMPRESS Horizon Europe project. It aims to contribute to the development of the Municipal Emergency Management Plan (PEMU, its acronym in both Catalan and Spanish) through risk mapping, vulnerability assessment, and disaster response measures. This approach has also been implemented in three other case study areas, at different scales and in various contexts: the Centro Region of Portugal, the Egaleo Municipality in Greece, and the Ordu Municipality in Turkey.

2. Disaster risk governance and management

2.1 Human vulnerability to natural hazards: evolution of the concept

In the mid-1970s, within the context of critical studies on development, several authors introduced the notion of vulnerability, referring to the possibility of being affected by a potentially hazardous event and highlighting the conditions within a given society that contribute to the transformation of a natural hazard into a disaster (Revet, 2011). During the same periods, P. O'Keefe, K. Westgate, and B. Wisner developed their "radical" approach within the Disaster Research Unit, founded by J. Lewis in 1973 at the University

of Bradford, demonstrating the link between development levels and the occurrence of disasters (Wisner, O'Keefe, & Westgate, 1977). The authors challenged the notion that natural disasters are purely "natural" events (O'Keefe, Westgate, & Wisner, 1976). They argued that disasters result from an interaction between natural hazards and social, economic, and political vulnerabilities. These vulnerabilities are shaped by global structures—such as world economic systems and development policies—that marginalize certain populations and expose them to more risks. They emphasized the importance of considering local knowledge ("peoples' science"), which is often ignored or underestimated by experts and official institutions. In fact, communities possess valuable knowledge about their environment and their adaptation mechanisms, which should be central to any risk reduction strategy. This was a pioneering attempt to rethink human vulnerability by recognizing its social origins beyond so-called "natural" disasters, through fieldwork and analysis. In the 1970s, these ideas, considered radical at the time, were developed further by researchers such as Ben Wisner and Ken Westgate, the French anthropologist Jean Copans (1975), and the Canadian geographer Kenneth Hewitt (1983) (Revet, 2012).

The transition toward a systemic and multidisciplinary perspective—encompassing exposure, sensitivity, adaptive capacity, and resilience—has enhanced analytical frameworks, but it also intensifies debates surrounding the polysemous nature of the concept (Quenault, 2015).

One can highlight the significant contribution of social sciences in analyzing and understanding risks, defining vulnerability, and critiquing technocratic and top-down approaches that marginalize local knowledge. These insights have fueled reflection and discussions on disaster risk management and disaster governance.

2.2 Concept of disaster governance

The concept of disaster governance emerged in its advanced form in the United Nations Development Programme (UNDP) report 'Reducing Disaster Risk: A Challenge for Development' in 2004. Disaster governance is a collaborative effort that brings together multiple organizations to solve disaster-related issues that extend beyond the purview of any single organization (Vij 2023, O'Leary et al., 2006; Ansell & Gash, 2008). Additionally, Bakema et al (2019) advocated for a holistic comprehension of disaster governance, emphasizing its social nature influenced by cultural, historical, emotional, political, economic, and power dynamics among diverse state and non-state entities. One observation that can be made is that poorly governed societies and weak states are almost certain to exhibit deficiencies in disaster governance (Tierney, 2014). State-civil society relationships, economic organization, and societal transitions have implications for disaster governance. The concept of disaster governance marks a transition from government-centric to a broader governance approach, reflecting significant social and political transformations characterized by the rise of new collaborations between state and non-state participants (Tierney, 2014). The predominant model for response and recovery in disaster governance is a top-down approach. However, the following sections illustrate how participatory approaches are increasingly promoted in disaster risk reduction, with growing support from scientists, European agencies, and the United Nations for their integration into risk management strategies.

2.3 Disaster risk management cycle

According to United Nations Office for the Disaster Risk Reduction (UNDRR), disaster-risk management is the systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities to lessen the adverse impacts of hazards and the possibility of disaster. When successful, disaster-risk management efforts aim to reduce the effects of hazards through activities and measures related to prevention, mitigation, and preparedness (UNDRR, 2024). Effective disaster risk management involves several strands including prevention (risk reduction), preparedness, response, and recovery. Disaster risk management responsibilities and tasks differ across governance levels—national, regional, and local—each bringing distinct strengths and limitations in responding to such risks.

2.4 Risk management at the local governance level in the Balearic Islands, strengths and weaknesses

In the case of the Balearic Islands, the competence of risk management at the regional level is carried out by the Autonomous Government of the Balearic Islands through the Law 3/2006, of March 30, on Emergency Management in the Balearic Islands[1]). It performs the Territorial Civil Protection Plan (PLATERBAL) and several special plans addressing specific hazards such as floods (INUNBAL), adverse meteorological phenomena (METEOBAL), and wildfires (INFOBAL), among others. These plans define the operational framework for emergency management, including operational situations classified into different levels according to severity and scope of risk; activation criteria based on technical indicators and early warning systems (EWS); an organizational structure establishing command and coordination bodies, operational response groups and coordination centers; and the response procedures set out through specific protocols. At the local scale, risk management falls under the responsibility of the village/city council and is carried out through the Municipal Emergency Plan (PEMU). The PEMU is a planning tool that enables the prevention and management of emergencies within the municipality by identifying relevant risks, assessing available resources and defining coordination and response mechanisms with the different services and administrative bodies. These plans are a key component of the civil protection structure and are integrated into the regional risk management system as the first operational level in response to low-risk situations. Their integration into the broader regional and national emergency management framework follows a tiered structure: low risk – local management, moderate/high risk – regional management, and very high risk – national coordination. Specifically, within the operational and structural framework of the PEMU, a hierarchical structure is defined for each risk level, detailing the designated responsible parties and the specific functions assigned to each of them.

Risk management involves multiple stakeholders, but their implication is constrained by several challenges, including the lack of municipal emergency plans, limited interinstitutional coordination, insufficient financial resources, and restricted legislative capacity. Although the regional and national levels possess more established frameworks

[1] https://www.caib.es/sites/institutestudisautonomics/f/174259

and resources, operative effectiveness is limited by geographic distance and administrative delays. The private sector contributes through technological innovation, but its involvement is often based on fragile contractual agreements motivated primarily by economic interests. Civil society and academia provide valuable territorial and scientific knowledge but rely heavily on volunteer work and external funding. These vulnerabilities are exacerbated by increasing risk frequency, climate change impacts, and slow post-disaster aid responses. Specifically, in the Balearic Islands, only 6 of 67 municipalities have developed PEMU, despite having the institutional capacity to do so. Consequently, the management of risks frequently relies on the intervention of the regional government. Furthermore, there is a significant lack of coordination among the various administrative bodies and stakeholders involved in emergency management, often stemming from misunderstandings regarding roles and operational protocols. This situation is exacerbated by limited financial resources and a lack of legislative autonomy at the local level, which together constrain the effective implementation of both preventive measures and emergency response actions.

A clear example of this gap is the municipality of Puigpunyent, one of the municipalities in the Balearic Islands without PEMU. Its location and characteristics make the municipality vulnerable to several natural hazards such as wildfires, floods, landslides, and extreme climatic events. Historically, the municipality has been affected by such extreme events, including: (i) the 2007 Sa Riera flood, which caused one fatality on the main access road to Puigpunyent village; (ii) the 2001 wildfire, which burned 2 hectares in Son Net area; (iii) the Juliette destructive storm in 2023, during which intense precipitation and snow accumulation affected the municipality's forested areas and disrupted transit between the villages urban centers of Galilea and Puigpunyent; (iv) and the severe hailstorm in April 2025, which led to the closure of the municipality's main road.

3. Participatory approaches to strengthen territorial resilience to climate clange

3.1 Enhancing participatory approaches within international and European policy instruments

The Sendai Framework, a successor instrument of the Hyogo Framework for Action of the United Nations, overseen by the UNDRR, is the first major agreement of the post-2015 development agenda and offers Member States concrete measures to safeguard development gains from disaster risk. It advocates for "the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries." It recognizes that "the State has the primary role to reduce disaster risk, but that responsibility should be shared with other stakeholders, including local government, the private sector and other stakeholders" (UNDRR, 2015). From 2015 to 2030, Member States worldwide will undertake various initiatives within the framework's four Priority Areas, aiming to diminish risks and ultimately minimize losses caused by natural hazards. Among the four Priorities for Action of the Sendai Framework, priority 2 "guides, encourages and incentivize the public and private sectors to take action and address disaster risk" to strengthen disaster risk governance to manage disaster risk.

UNDRR facilitates the implementation of the Sendai Framework for Disaster Risk Reduction by engaging systematically and strategically with diverse stakeholders, reaffirming the importance of participatory approaches. UNDRR (2015) emphasizes that effective disaster risk reduction hinges on a whole-of-society approach. Indeed, the Sendai Framework advocates for a broader, more people centred approach to disaster risk, emphasizing that "disaster risk reduction practices need to be multi-hazard and multisectoral, inclusive and accessible in order to be efficient and effective".

The Sendai framework also advocates that it is the government's responsibility to assume the leadership, regulation and coordination role, in addition to communicating with all the people ("women, children and young people, people with disabilities, the poor, migrants, indigenous peoples, volunteers, the community of practice and older people") involved in the design and implementation of policies, plans and regulations. The public and private sectors, the civil society organisations and the academy should work more closely together and create opportunities for collaboration and integrate disaster risks into businesses' management practices (UNDRR 2015). The Sendai Framework works hand in hand with the other 2030 Agenda agreements, including the Paris Agreement on Climate Change, the Addis Ababa Action Agenda on Financing for Development, the New Urban Agenda, the 17 Sustainable Development Goals (SDGs), adopted by the United Nations in 2015.

There is now a converging perspective among European and UN agencies, experts, and local stakeholders regarding the meaning and importance of community and civil society engagement in risk prevention and management, as a means to enhance overall effectiveness. This convergence also entails the implementation of participatory approaches to make protocols more efficient.

3.2 Participatory governance and approaches in disaster risk reduction

As climate change and other threats continue to amplify the severity and frequency of natural disasters, there is a growing recognition that traditional top-down, centralised approaches to disaster management are often inadequate (Mayer, 2019). In this context, participatory governance and people-centred approach are promoted, as previously mentioned.

The concept of polycentric governance (PG) has emerged as a promising framework for enhancing community resilience and enabling more effective disaster risk reduction. The contemporary concept of "polycentricity" was initially introduced by Ostrom, Tiebout, and Warren (Ostrom 1961, Ostrom, 1990; Ostrom, 2010). Polycentricity, or what the authors call a "polycentric political system", involves multiple centers of authority and decision-making in a common geographical area. Each of these centers has a level of autonomy and accountability for managing its area of responsibility. This decentralized approach contrasts sharply with a unitary model where a single central government holds complete authority over the entire urban area. The most persuasive normative rationale behind defending PG against monocentric governance is the expectation that distributing decision-making authority across multiple centers will lead to more effective, responsive and equitable governance outcomes (Ostrom, 2010; Aligica & Tarko, 2012; Schoon *et al.,* 2015; Carlisle & Gruby, 2019; Stephan *et al*., 2019).

Wisner et al. (2003) advocate for a participatory and equitable approach to risk reduction. Their bottom-up method emphasizes the recognition of local knowledge, the strengthening of community capacities, and the promotion of social justice and empowerment. Indeed, social learning is often overlooked in analyzing the social dimensions of risks and disasters. Ross et al. (2023) concluded in their research that social learning can help change practices by creating more lasting and effective responses for future disasters. In addition, the study found that social learning encourages resilience-oriented approaches. They also noted that social learning provides an opportunity to make sense of changes, create a broader set of strategic options and foster innovation.

This emphasis on participation, empowerment, and local knowledge closely aligns with the people-centred approach to risk management, which emerged from the growing recognition that effective risk reduction must prioritize the needs, knowledge, and capacities of individuals and communities. Originating from the fields of sustainable development and disaster risk reduction, particularly emphasized in the early 2000s through frameworks like the Hyogo Framework for Action (2005-2015), this approach shifts the focus from purely technical or institutional solutions to inclusive strategies that empower those most at risk. It is strongly advocated by international organizations such as the United Nations and NGOs, which highlight the importance of local engagement, participatory planning, and culturally appropriate interventions. By valuing the lived experiences and insights of affected populations, the people-centered approach ensures that risk management strategies are more effective, equitable, and sustainable.

3.3 The PPCP approach methodology

The Public-Private-Civil Partnership (PPCP) is an inclusive and participatory approach to strengthen the involvement of stakeholders from the public, private, and civil society sectors in disaster risk management and climate change resilience, as shown in Figure 1. This approach draws inspiration from other methods such as Public-Private-People-Partnership (PPPP), also called 4P's, introduced by several researchers (Irazabal, 2016; Ng, 2013; Sihombing *et al*, 2018; Seddighi *et al*, 2021) and promoted within the United Nations Economic Commission for Europe (UNECE, 2018). The goal is to support inclusive, citizen-led innovations for tackling complex urban issues and to highlight the critical role of people as partners in formal and informal urban (re)development processes. Indeed, people and communities have often been the most vulnerable stakeholders, frequently excluded from partnership processes. Therefore, the main objective of the PPCP approach is to support territories in co-constructing effective responses to disaster risks. It fosters stronger stakeholder engagement and inclusion, enhancing societal resilience by improving coordination across levels of governance and promoting participatory processes that lead to more integrated and informed decision-making.

In fact, the PPCP approach builds on a paradigm shift by including civil society, understood as organizations (associations, collectives, committees, NGO, etc) that bring together citizens and advocate for their interests. This approach enables the integration of various stakeholders in the co-creation of resilient solutions to climate and disaster risks.

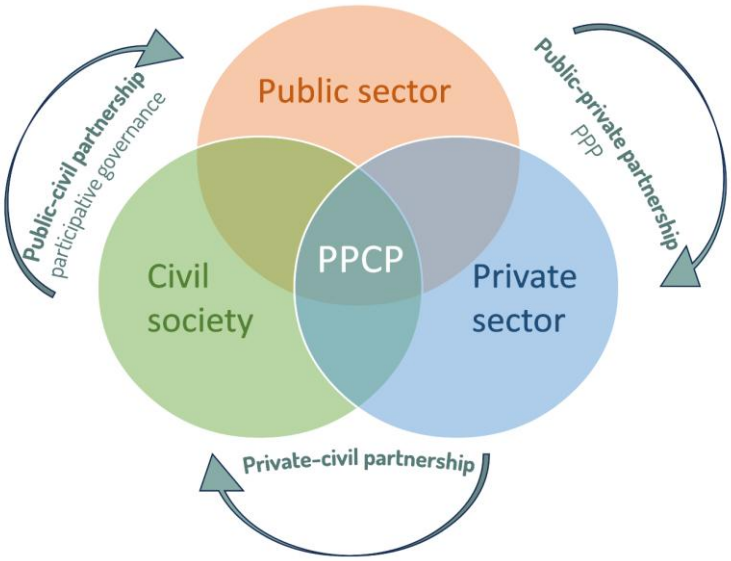

Figure 1: *Conceptual framework of the PPCP approach*
Note. From C2IMPRESS project, by ARTELIA, [2025].

The specific objectives of the PPCP are the following: (i) to incorporate civil society into decision-making processes in conjunction with the private and public sectors at the territorial level; (ii) to propose a new multi-party engagement structure; (iii) to increase acceptability and transparency of governance actions; (iv) to improve collective intelligence and public awareness on disaster risk management and climate change; and (v) to foster the sharing of knowledge and beneficial experiences as well as the reproduction of good practices in risk management and more generally to climate change.

The PPCP approach offers a structured and replicable framework for implementing collaborative governance in disaster risk management and resilience-building. Rather than simply identifying who should be involved and why, PPCP focuses on the practical "how", providing a clear, step-by-step methodology for turning multi-stakeholder collaboration into concrete action.

At the core of the approach is the creation of PPCP Labs, or collaborative workshops, which are designed as social learning environments where stakeholders co-create and co-design solutions to specific territorial and environmental challenges, such as risk governance and climate change adaptation. These Labs are guided by detailed instructions, practical toolkits, and a dedicated PPCP Implementation Guide. This "toolbox" is adaptable to different audiences and local contexts, making it possible to tailor the process to each territory's specific needs and dynamics. This operational flexibility gives PPCP a strong replicability potential, enabling its application in a wide range of settings.

During the various PPCP Labs implemented, stakeholders were invited to reflect on the current context of risk management in their territory, as well as on the barriers and potential levers for improvement. This collective reflection was facilitated through a range

of tools such as participatory stakeholders mapping, SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis, risk mapping, etc.

An additional strength of PPCP lies in its emphasis on institutionalizing the outcomes of the co-creation process. Results generated through the Labs are deliberately integrated into local governance frameworks, ensuring that community-driven ideas are translated into formal strategies and budgeted actions. This tangible integration strengthens the local institutional context (embedding collaborative governance into civil protection plans, territorial development strategies, or climate adaptation policies) and enhances the sustainability of the approach beyond the project timeframe.

The PPCP approach was implemented through the C2IMPRESS project into four case study areas, including the Balearic Islands. Figure 2 illustrates the insertion of the PPCP approach in the improvement of disaster risk governance and management.

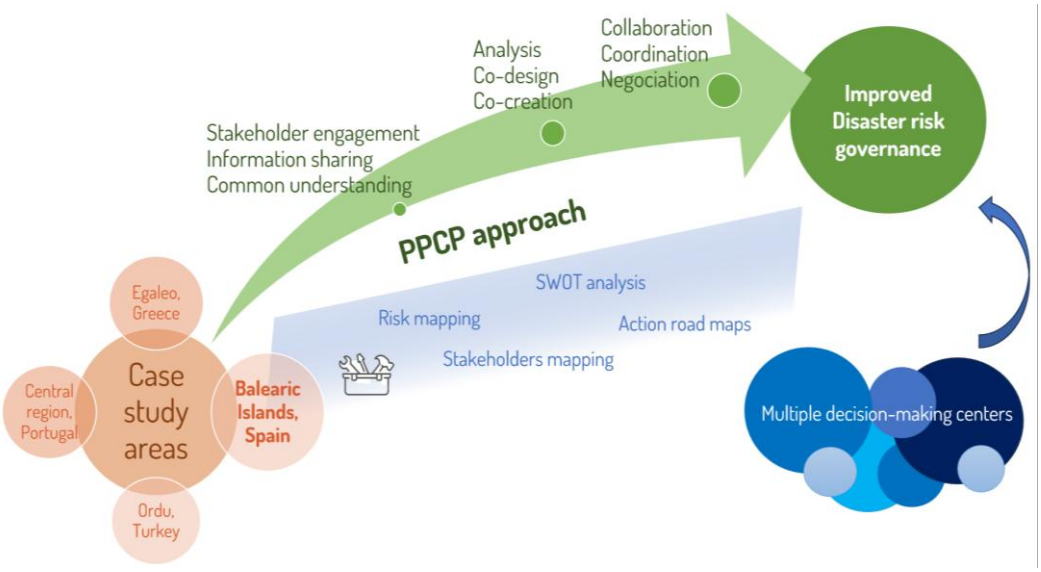

Figure 2: *Global view of the PPCP approach implementation through the C2IMPRESS project*
Note. From C2IMPRESS project, by ARTELIA, [2025].

In essence, PPCP provides:

- A structured and adaptable co-creation process: through iterative Labs, stakeholders engage in joint planning and decision-making, supported by a flexible set of tools that promote local ownership and long-term appropriation.
- Integration into local governance: by explicitly linking partnership activities to formal planning instruments, PPCP reinforces and contributes to the local governance framework, increasing the likelihood that co-designed solutions will be adopted, institutionalized, and sustainably funded.

In the case of Puigpunyent, one of the municipalities in the Balearic Islands, it currently lacks a PEMU. In light of the challenges previously outlined, how can the implementation of the PPCP approach help to facilitate dialogue from a participatory perspective, with a view to providing a more appropriate and effective response to risk management?

The following sections explain how the PPCP approach was implemented in the Balearic Islands to facilitate the co-construction of the Puigpunyent's PEMU.

4. Implementation of the PPCP approach to the Puigpunyent case study

4.1 Study area

Puigpunyent is a municipality located on the western part of the Tramuntana mountain range, on the island of Mallorca (Spain). It covers an area of 41.3 km² with a population of 2,069 inhabitants (IBESTAT, 2025) distributed across the villages of Puigpunyent, Galilea, and Son Serralta. The municipality is situated at the headwaters of the Sa Riera River catchment, which covers an area of 59 km². The stream crosses the village of Puigpunynent (covering the catchment at this point 8,25 km²), dividing it into two sectors. According to flood-prone areas cartography for 10-, 100-, and 500-year return periods, these sectors may become isolated during flood events. The predominant land use is forestry, accounting for 65% of the municipality, with 74% of the territory classified as high wildfire risk according to the IV General Plan for Forest Fire Defense. In addition, the presence of contact zones between modern materials from the Paleogene-Neogene and older materials from the Jurassic within the thrust fault system of the Tramuntana Range is noteworthy. These zones are susceptible to landslides and rockfalls.

4.2 Anticipated outcomes and expected results of applying the PPCP approach

The PPCP approach can be implemented in the early stages of drafting a PEMU, with the aim of improving emergency planning and response by encouraging the active participation of public, private, and civil society sectors. Accordingly, it is considered a key approach for the identification of local perceptions, needs, and challenges related to risk management and emergency response, as well as for the collection of local knowledge concerning natural hazards and associated historical events. This process of collaboration and information exchange among the different sectors is a fundamental component for shaping a functional and operational plan, being not only coherent but also carefully adapted to the unique characteristics, challenges, and evolving needs of the municipality and that is understood, accepted and actively used by the community. Finally, the PPCP approach implementation was considered as an opportunity to raise public awareness about the importance of performing a locally adapted PEMU, highlighting the main risks affecting the municipality. Therefore, this approach was implemented through the drafting process of the PEMU at Puigpunyent municipality to assess its effectiveness in: (i) creating a local communication and collaboration network, (ii) compiling necessary and relevant information for the PEMU's sections, and (iii) supporting the establishment of a governance framework and ensuring that stakeholders are aware of their roles and responsibilities.

4.3 Activities carried out

The implementation of the PPCP in the municipality was carried out through two Labs organized by the Observatory of Natural Risks and Emergencies of the Balearic Islands (RiscBal) in collaboration with the Village Council. They were held in February and May 2025 for a duration of half a day each (9:00 a.m. – 2:00 p.m.). To ensure broad representation, a total of 43 stakeholders with operational capacity during municipal emergencies were invited. The private sector was represented by local companies with relevant logistical resources (e.g. machinery or supplies), civil society by members of associations and civil protection volunteers, and the public sector by municipal technical staff, emergency services, and regional institutions involved in risk management. Finally, a total of 22 stakeholders attended as described below:

- Public sector: General Directorate of Emergency and Interior - DGEI, Balearic Forestry Service, Civil Guard, Local Police, SAMU 061, Puigpunyent Town Hall, Municipal maintenance crew, Civil Protection Volunteer Group, Elderly Care Home, Nursery School, Primary school.
- Private sector: Reserva Puig de Galatzó Nature Park, local businesses.
- Civil society: Cultural Association "S' Arreplegada", Cultural Association "Gall de Foc", Son Net, neighbourhood Association, Senior Citizens' Association, Parents' Association.

Five activities were carried out, previously selected based on their informational potential and their relevance to the sections of the PEMU, for which the data collected could be useful. These activities were structured into three categories: (i) risk identification and mapping, (ii) operational scenarios, and (iii) vulnerability assessment.

For risk identification and mapping, various municipal risk maps were first presented to stakeholders to gather their feedback on the main hazards affecting the area. The identified risks were then categorized into two groups: (i) anthropogenic—such as explosions, hazardous materials accidents, and missing person rescues—and (ii) natural—including floods, wildfires, landslides, and climate-related hazards. This was followed by a participatory discussion to gather participants' perceptions and concerns about these risks.

The second activity focused on identifying and characterising critical points and vulnerable areas. Working in groups, participants analysed six maps covering the main urban areas of the municipality (the whole area of the municipality; villages of Puigpunyent, Galilea, and Son Serralta; and clusters of isolated dwellings in Son Net and Conques). They marked risk zones and critical points using color-coded stickers based on the type of hazard. The colors used were as follows: blue for floods, red for wildfires, yellow for climate-related risks, green for landslides, and black for anthropogenic risks. Each marked location was further described with post-it notes containing qualitative information on observed impacts and related historical events. These notes were also color-coded to reflect the frequency of the reported events.

Figure 3: *Map of critical points and areas in Puigpunyent, and participants working on the action guide.*

For the operational component of the PEMU, two additional activities were implemented. Their objectives were to define operational emergency scenarios, identify priority actions, assign responsibilities among stakeholders, and promote the involvement of the public, private, and civil society sectors. These activities centred on planning the necessary measures to respond effectively to emergencies. The first activity presented a generic emergency context. Participants were asked to define key actions for each of the three phases of emergency management—before, during, and after the event. Special attention was given to vulnerable groups, critical infrastructure and facilities, and communication with the population. Additionally, participants were required to identify the stakeholders responsible for implementing each proposed action. The second activity consisted of a tabletop exercise based on three specific scenarios: a flood, a wildfire, and a search for a missing person. Participants were divided into three groups, each assigned to one of these scenarios. Their task was to establish a timeline of proposed actions for managing the emergency and to assign specific responsibilities to the relevant stakeholders for their implementation.

Finally, for the vulnerability assessment, an open discussion about "What is a just and resilient society?" was carried out, with a particular focus on identifying vulnerable groups, their specific needs, and their proper inclusion in the PEMU.

5. Results and discussion

5.1 Risk identification

For the identification and analysis of risks present in the municipality, the stakeholders from the different sectors primarily highlighted flood risks, wildfires, and windstorms. This perception is based on the historical occurrence of adverse events and the recurrent impact of these events on the road network, especially on access routes to villages and isolated dwellings. The access roads to the municipality are lined with forested areas, increasing their vulnerability to wildfires or falling trees or branches during events of strong winds or snowfall. Furthermore, the main access road is located within the floodplain of the Sa Riera River, increasing its susceptibility during overflow episodes. In the discussion, private sector and civil society stakeholders emphasized identifying key risk scenarios and improving the municipality's emergency response capacity. In contrast, the public sector—especially the Puigpunyent Village Council—focused on the need for clear protocols to define each actor's responsibilities throughout emergency management.

Given that many PEMU duties fall to them, their main concern is understanding their specific roles in each situation.

5.2 Risk mapping

The analysis based on the geolocation and characterization of critical points and conflict zones enabled the identification of the most recurrent risks and the areas commonly affected. The stakeholders identified a total of 10 risks through the analysis of the six maps. These risks were spatially represented through the identification of a total of 49 locations (critical points and conflict areas) (Table 1). The spatial distribution reflects a wide exposure to wildfire risk, linked to the extensive presence of continuous forest patches throughout the municipality. In contrast, dwellings located in floodplains, steep and/or rocky areas and the road network were identified by the stakeholders as critical points for flood and landslide risk, coinciding with the recurrent occurrence of these phenomena in the identified areas.

Table 1: *Number of points and zones identified on each map according to the associated risk*

Maps	Risk type					
	Floods	Wildfires	Landslides	Climatic risks	Anthropogenic risks	Total
Municipality of Puigpunyent	3	5	2	5	4	19
Puigpunyent	3	1		2	3	9
Galilea		1	2	2	1	6
Son Serralta	2	1				3
Son Net		2	2	3	1	8
Conques		1	1	2		4

5.3 Recommendations for the PEMU Action road map

Regarding the operational component of the plan, the participants designed one generic action guide and three additional guides adapted to the three specific scenarios. The stakeholders developed a generic guide identifying a total of 13 operational measures developed by the stakeholders: 4 for the 'before' phase, 4 for 'during,' and 5 for 'after.

First, the *before-phase* measures were focused on promoting risk education and self-protection, developing cartographic tools to better support vulnerable groups, identifying safe locations for emergency management, and establishing official communication channels with contingency options in case of network outages. All these measures aimed to minimize impacts during an emergency. Second, at the *during-phase*, the relevance of the evacuation or shelter-in-place protocols based on the nature of the emergency was emphasized, to ensure effective assistance. This was complemented by the prior identification of assembly points and temporary accommodation, along with planning the logistics for essential resources and supplies. Furthermore, attention was given to managing access and evacuation routes, maintaining communication efficiency to

guarantee a coordinated and effective response of the emergency corps. Finally, in the *after-phase*, the defined measures focused on analysing the emergency management process. This analysis is essential for identifying shortcomings and proposing improvements to the plan, as well as assessing the condition of infrastructure, equipment, and the affected environment during the emergency. Participants also recommended developing lessons learned and conducting SWOT analyses, alongside gathering information to understand citizen behaviour. The aim is to strengthen the culture of risk awareness and to carry out drills to evaluate the effectiveness of the proposed improvements. Particular attention was also paid to assessing the performance of communication channels used during the emergency.

Regarding the three additional guides adapted to three specific scenarios, the proposed actions were very similar to those previously described. In this context, participants focused on defining the chronological sequence of actions and identifying the stakeholders responsible for their implementation, with the aim of moving towards a more operational and actionable plan. They also examined the point at which the management of the emergency would shift from the local council to the responsibility of the Balearic Government—an important aspect of risk management. Even when an emergency is escalated to a higher level, local stakeholders do not withdraw; they are expected to remain actively involved under the coordination and guidance of the Balearic Government. The outcomes of these activities have resulted in a reference guide in which participants identified the priority and essential actions and measures for risk management, along with the assignment of responsibilities to the respective stakeholders. This was useful to clarify the roles played by the different actors in the management framework. This guide will be used as a basis tool for the development of operational protocols tailored to the different scenarios outlined in the PEMU. Specifically, this set of actions proposed by the participants will be analyzed and reinterpreted by a group of scientific experts, such as RiscBal, and by emergency management specialists, including the DGEI and the municipal officer responsible for this field in Puigpunyent. The objective is to select those proposed actions that can be incorporated into the PEMU, based on their operational and legal feasibility.

Finally, in accordance with the disaster risk management cycle, the activities have addressed the different phases of prevention, preparedness, response, and recovery. A clear example is the analysis of the wildfire scenario. Regarding prevention and preparedness, participants proposed measures such as creating forest buffer strips in the most critical areas of the municipality, clearing access roads, and establishing fire protection perimeters around houses located in forested areas. For the response phase, the importance of having an early warning system for fires was highlighted, as well as ensuring coordination and emergency management among the different stakeholders. This includes actions such as communicating with the population, carrying out evacuations, or implementing confinement measures if necessary. Lastly, in the recovery phase, participants emphasized the need and usefulness of conducting post-disaster meetings with stakeholders to assess the situation and evaluate the management carried out.

5.4 Vulnerability assessment

Finally, the stakeholders were invited to identify groups they considered more vulnerable to climate change. They identified three groups of population as particularly vulnerable: children, the elderly, and people with physical and/or mental disabilities. Special emphasis was placed on the situation of older individuals who live alone and have difficulties accessing emergency information, as well as people with some disabilities, whose evacuation may require external assistance. The direct participation of representatives from these groups enabled a more accurate characterization of their specific needs.

The stakeholders also formulated proposals to be included in the PEMU, focused on improving the attention of these vulnerable groups including (i) the establishment of a local volunteer network to support emergency services in assisting these groups; (ii) the development of a geolocated registry of vulnerable individuals to facilitate rapid and effective response; (iii) the design of a specific communication system using fixed or mobile loudspeakers to ensure the delivery of clear instructions; and (iv) the implementation of training workshops following the approval of the PEMU, aimed at empowering vulnerable individuals with self-protection strategies to be followed during emergency plan activation.

5.5 Advantages and limitations

The application of the PPCP approach to risk governance design, as in the specific case of drafting the PEMU, presents both advantages and limitations. A key advantage is the inclusion of representatives from the public, private and civil society sectors, which goes beyond the traditional public–private partnership (PPP) (Žuvela et al., 2023). This broader participation enabled civil society to share local knowledge of existing issues and risk management requirements. It promotes a more interactive process that combines technical expertise with local insights. The information gathered through this combination of knowledge is especially useful for drafting a PEMU that is tailored to the specific characteristics and situation of the municipality. This helps avoid creating generic plans that often do not meet the actual needs of local areas.

However, a significant limitation is the difficulty of maintaining the active engagement of private sector and civil society stakeholders, given their limited interest in participatory methods (Žuvela et al., 2023). The low participation in our case study was mainly due to the morning schedule which conflicted with participants' working schedule, as explained by participants who were unable to attend. Another reasoning was the lack of clarity about their potential contributions and the usefulness of their involvement. For future editions, it is recommended to hold the workshops in the late afternoon and to conduct prior dissemination, clearly outlining their objectives and the expected contributions from participants. This issue is exacerbated by the absence of long-term strategies to support and sustain their involvement, as evidenced by the decline in participation between the first and second labs.

Moreover, although the PPCP approach is valuable in the early and follow-up phases, the drafting of emergency plans remains under the responsibility of local and regional authorities. Therefore, the PPCP approach should be seen as an opportunity to foster dialogue among different sectors and enhance the relevance of risk management

plans, ensuring social validation complementing technical planning processes as a feedback process to enhance citizen awareness.

Lastly, the methodology was tested in a small rural municipality where the population is concentrated in three urban settlements and dispersed housing. This municipality is characterised by a high level of territorial knowledge and close relationships among participants at the local scale. Future research should assess the feasibility of replicating these workshops in municipalities with different population sizes and spatial distributions, with the aim of analysing how these factors influence PPCP dynamics, the relationships among stakeholders, and the population's level of territorial knowledge. We would expect that the workshops could be replicated easier in settings where citizens are engaged with the community and the environment.

6. Conclusion

The implementation of the PPCP approach during the preliminary phases of drafting the Municipal Emergency Plan of Puigpunyent generated valuable information that may be relevant for inclusion in the PEMU.

Firstly, the PPCP Labs enabled the co-creation of a preliminary local collaboration network. This network included key stakeholders expected to take part in emergency management once the PEMU was in place. However, the limited participation of the private sector and civil society constrained the development of a fully representative and inclusive stakeholder network. Inclusive participation, particularly in terms of sectoral representation, is a key element in ensuring the effectiveness of the co-creation process and in fully exploring the approach's transformative potential for building climate risk resilience.

Secondly, the activities focused on identifying the main risks affecting the municipality, as well as the critical points and vulnerable areas associated with them, made it possible to create a database combining both qualitative and quantitative information. This was achieved through the integration of local knowledge. This information will serve as the basis for a more detailed risk analysis of the municipality, supporting both the territorial characterization and the risk assessment required by the PEMU. In addition, data related to critical points and vulnerable areas must be considered in the design of operational scenarios and the development of protocols associated with each identified risk.

Thirdly, the action guidelines developed by the stakeholders outline key emergency management measures and will support the drafting of the PEMU protocols. These protocols will also incorporate proposals and identified needs that emerged from the vulnerability analysis conducted by the stakeholders during the PPCP Labs. Furthermore, participatory data will help align the PEMU with local realities and the needs expressed by stakeholders, once their operational and legal feasibility has been confirmed by experts as previously mentioned.

Even if all quantitative and qualitative data collected through the PPCP approach implementation must be processed and analyzed by risk management experts to adapt it to the specific requirements of each section of the plan, these initial results form the basis for this first stage in the drafting of the PEMU.

Finally, the generated data is essential for both the development and implementation of the PEMU, serving as a key instrument that provides the accuracy and reliability required of an effective strategy for local-scale decision-making throughout the emergency management cycle. Moreover, the results of the Puigpunyent case study offer a replicable framework that can inform the design of municipal emergency plans. In the specific context of the Balearic Islands, incorporating this comprehensive and participatory approach into the development of PEMUs -one that fosters awareness among both citizens and authorities- can significantly improve lead time during emergencies, while also facilitating the integration of early warning systems to strengthen territorial resilience. All these technologies and approaches have been thoroughly researched and applied at an advanced level within the framework of the C2IMPRESS project, further validating their effectiveness and real-world applicability, demonstrating once again the key role of local stakeholders for territorial resilience.

Thus, the PPCP approach has contributed in a concrete and operational way to improving risk management by incorporating the diverse perceptions of risk held by different sectors (public, private and civil). By fostering inclusive dialogue and structured collaboration through the Labs, PPCP enabled a more accurate and context-sensitive understanding of territorial vulnerabilities. As a result, it supported the development of a more tailored and relevant risk management plan that reflects both technical considerations and stakeholder priorities.

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