Rethinking Inner Areas Through AI: Hybrid Approaches for Inclusive Planning

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Abstract. This paper critically examines the implications of Artificial Intelligence (AI) for inner area regeneration, serving as a vital testing ground for AI's contradictions in territorial planning. As non-neutral technologies, AI systems prioritize quantifiable data, often rendering invisible those local resources that resist simple encoding. In these regions, territorial value is deeply rooted in relational, cultural, and ecological dimensions that risk being overlooked by quantitative models. As spatial planning increasingly relies on AI-driven predictive models, there is a danger of standardizing territorial narratives and flattening local specificities. Moreover, predictive models trained on historical data often perpetuate existing inequalities. Inner areas face a "double disadvantage": scarce, low-quality data produces distorted, self-referential forecasts that reinforce marginalization. To counter these risks, engaging local communities in dataset creation and the rediscovery of cultural specificities is essential.

Drawing on the PRIN INSITE project, this paper proposes Hybrid Intelligence (HI) practices where AI systems and local knowledge coexist through participatory processes. The objective is to shift territorial development from an efficiency-centric model toward an inclusive, contextual paradigm that accurately interprets the unique potential of inner areas.

Keywords: Inner Areas · Artificial Intelligence · Hybrid Intelligence

1 Introduction: Planning beyond Efficiency

Inner areas act as testing grounds in the face of paradoxes arising from the use of Artificial Intelligence (AI). These regions should no longer be viewed simply as "peripheries" to be explored, but rather, as generative sites for redefine the interaction between technology, community, and cultural heritage. They are complex regions that hide unique networks of relationships, cultural heritage and ecological values, and underneath their surface edges deep human, historical and natural connections, i.e. the immaterial context that shapes their essence (Italy's National Strategic Plan 2021–2027).

This perspective permits us to shift the focus from the shortcomings of simple quantitative indicators to a qualitative paradigm in which relational networks acknowledge cultural heritage and ecological diversity as strategic resources in modern spatial planning. The real challenge is to overcome a single urban development model (Fistola &

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La Rocca, 2024), abandon a single functional efficiency goal, and explore a "situated" approach in order to preserve the identities of these regions from homologation.

Indeed, in inner areas intangible heritage represents their own resilience force. Currently, AI-enabled planning tends to be limited to optimization logic (for example maximizing agricultural production through land use models). This excessive focus on quantitative data threatens to marginalize or even erase the entrenched cultural heritage present in inner areas (Fistola & La Rocca, 2025). In the age of AI, a rethinking of urban planning is required to move from data and efficiency fascination to Hybrid Intelligence (HI) models, combining algorithmic intelligence with local knowledge.

Moving from these considerations, this study deals with the possibility of drawing new research paths for regional planning and territorial transformation government. The central point is a critical but constructive analysis of the potentialities that AI offers being aware about the loss of information that is inevitably associated with a digital process, however sophisticated. The final proposal of the study, thus, consists of investigating the coexistence between the perfection of the AI model and the nuanced perfection of the social aspects that emerge in a participative process.

This study contends that the "productive imperfection" of human decision-making remains indispensable for capturing the socio-cultural nuances that algorithms, by their very nature, are designed to smooth away, proposing a hybrid method to move toward a more resilient and authentic urbanism.

Driven by the goal of bridging the gap between algorithmic precision and human agency, this paper is structured in three main parts. In the first part, a theoretical framework about the concept of hybrid intelligence is establishes, both to situate the study within the contemporary debate on AI, and to support a caution approach to the "technocentric" paradigm.

The second part discusses the methodologic approach developed within a previous research project (INSITE), here adapted to capture the nuances of human-computer interaction using participative living lab aimed at involving local communities in the design for a territorial development plan. The third part describes the main results relating to hybrid fruition methods for places representative of specific territorial contexts.

Conclusions highlight that the proposal of this study should be understood as a path of research that still needs to be fully explored, but which aims to underline the need for a precise methodological choice in using AI to support territorial planning, particularly in inland areas.

2 Theoretical Framework

The concept of Hybrid Intelligence (HI) emerges as a critical and operational perspective capable of overcoming the dichotomy between automation and the local dimension, proposing a form of cooperation between artificial intelligence and human intelligence.

2.1 Hybrid Intelligence for Inner Areas

In the inherently fragile contexts of inner areas, HI can play a strategic role in rebalancing the asymmetries produced by predictive models that tend to prioritize what is measurable

and quantifiable in data, at the sacrifice of the relational, cultural, and environmental dimensions of the territory (Zingariello & Fistola, 2025).

Within this paradigm, by moving beyond the conception of AI as merely a technical tool preparatory to the automation of planning processes, we can recognize a dual configuration of artificial intelligence, particularly significant in a dialogic perspective between AI and citizens.

On the one hand, AI can serve as an information interface that is, as a tool capable of translating the systemic complexities of a territory that, especially in non-expert contexts, otherwise preclude access to territorial knowledge. The informational dimension allows residents to interrogate and interpret information related to their territory. In this sense, AI helps reshape the relationship between citizens and planning, bringing the latter closer to a dialogic and shared process.

From another perspective, AI can be seen as a facilitator of participatory processes, playing an active role in structuring and reporting local feedback. In this second configuration, artificial intelligence does not merely provide answers but actively contributes to the creation of participatory contexts by initiating and guiding conversations, bringing forth a variety of viewpoints, identifying relevant insights for planners, and highlighting user contributions and concerns that might otherwise go unheard. This is particularly relevant in inner areas, where the scarcity of structured data can be compensated for through the production of local data, generated directly by the communities. The mediation between these two dimensions can serve as an example of the definition and application of HI, in which human intervention manifests itself both in the design of the knowledge domain, with the informational dimension structured to make sources explicit and avoid uncertainties in the information provided, and through the collection and systematization of user feedback, which, when made available to planners, enables the participatory process to be activated.

These reflections are directly linked to another highly topical issue concerning the tension between over-trust and under-trust in artificial intelligence systems (Figoli et al., 2022), a crucial factor for the efficiency of participatory processes mediated by digital technologies. Excessive trust (over-trust) can lead both citizens and planners to attribute excessive authority to AI, uncritically accepting interpretations or directions emerging from conversational interactions. This risk is particularly relevant in the contexts of inner areas, where the lower availability of data and technical expertise among citizens can amplify trust in AI, reinforcing dynamics of decision-making delegation.

At the same time, a condition of widespread distrust (under-trust) can compromise the effectiveness of participatory tools limiting the involvement of local actors and reducing the availability to share considerations and points of view.

To overcome these dynamics, the conceptualization of AI as both an informational interface and a catalyst for participatory engagement can foster the emergence of "relational trust". Unlike traditional, *a priori* trust, this dynamic form of confidence can be continually renegotiated through the synergetic interaction between artificial and human intelligence. The informational conversation between citizens and AI allows, in fact, for the testing, verification, and questioning of the information produced, favoring a continuous process of calibrating trust. At the same time, the participatory facilitation

function helps shift the focus of trust from the technological system alone to the citizens themselves, recognizing their active role in the production of new information.

Based on insight from the research project INSITE (www.insiteprin2022.org), work has begun on the development of an AI-based chatbot (named "Heidy") designed to perform the dual function of an information interface and a facilitator of participatory processes.

3 Methodology: from the INSITE Project toward the Hybrid Intelligence Application

Methodologically this study represents the evolution of a long-term research trajectory initiated within the project INSITE (INtegrated Shared knowledge: from geo-paleontological herItage to present TErritorial challenges) aimed at the definition of a multidisciplinary protocol for the knowledge and the enhancement of cultural heritage in inner territories in Campania (South Italy). By integrating geo-paleontological data, structural vulnerability indices, and intangible values, INSITE established a robust, expert-led knowledge base aimed at identifying "hidden" territorial resources.

Figure 1 illustrates this continuity, showing how expert data is not merely stored but processed and returned to the community through a recursive loop of reciprocity. The methodology is structured into three sequential and interconnected levels, moving from the INSITE project input toward the definition of an inclusive planning process.

3.1 The Inputs of the INSITE Project

INSITE is a funded research project (PRIN 2022) whose main objective was to indagate the how geo-paleontological heritage could play as promoter for territorial regeneration in inner areas. The project particularly focused on two case study sites in Campania: the ichnosite known as "Ciampate del diavolo" (in Tora e Piccilli, CE), which preserves Pleistocene human and faunal fossil footprints; the paleontological site "Le Cavere" (in Pietraroja, BN), known to be the place where the first fossil sample of *Scipionyx samniticus* has been discovered. These two important sites for scholars and scientists remain practically unknown for non-experts and often for locals too. Both sites exemplify inner areas where exceptional scientific and cultural uniqueness coexists with territorial vulnerability, limited institutional capacity, and planning neglect, making them ideal contexts for examining the limits and possibilities of AI-assisted planning.

Thus, one of main objectives of the research was to involve local communities into a larger territorial revitalization design, starting from the assessment of the local territorial awareness and empowerment.

The project's structure integrated multiple targets (La Rocca & Amore, 2026) that can be summarized in:

- The definition of quantitative vulnerability and scientific relevance indices for defining the real enjoyability of the geosite also referred to the territorial context they were inserted into.
- The use of participatory techniques of "Living Lab" that involve local communities, government agencies and key stakeholders.

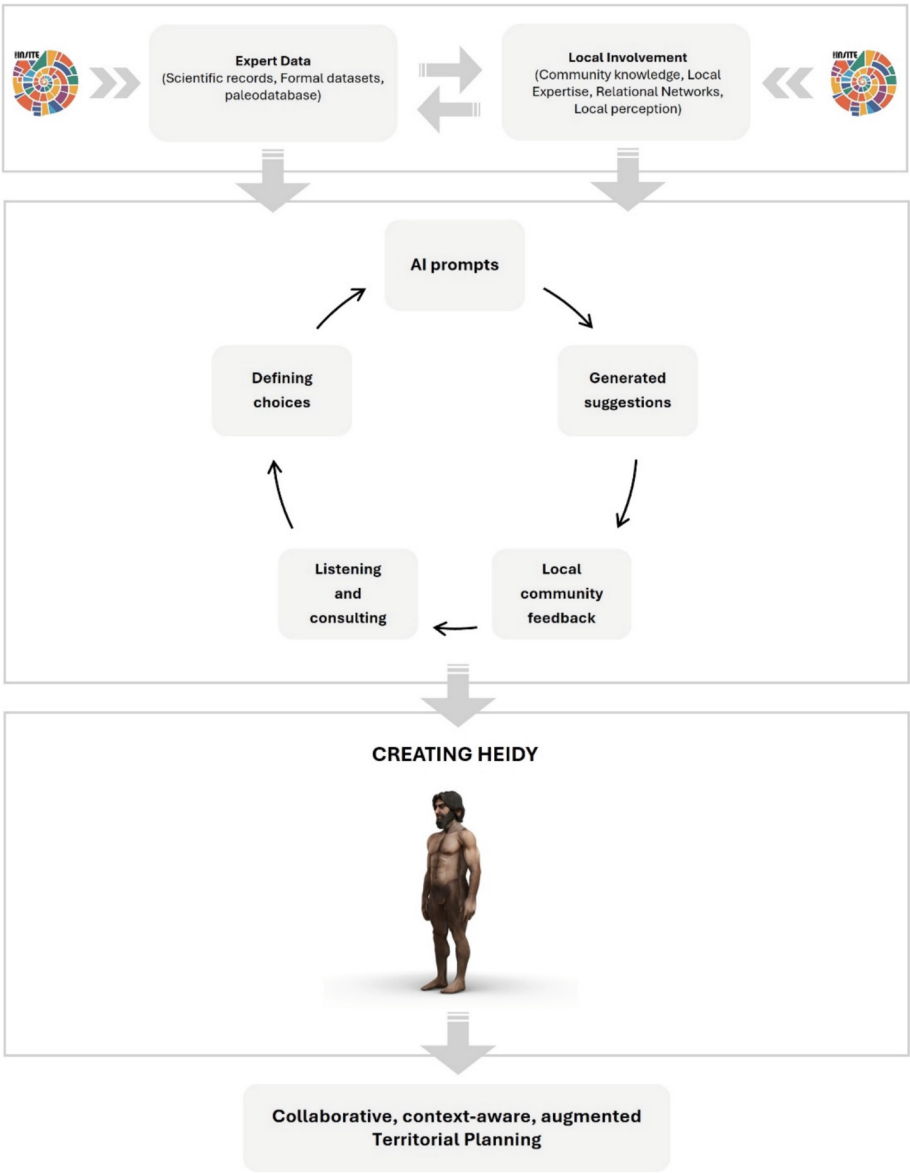

Fig. 1. The methodological phases of the study's development: in the initial phase, inputs derive from the research results previously developed in the INSITE project. The second phase indicates the information processing cycle aimed at building the "Heidy" prototype. The output of the process is the definition of a collaborative and inclusive planning process

- The design and the production of digital tools using augmented and virtual reality to propose innovative and captivated way to know and visit the geosites.

- The design of a Paleo-Cycle Path connecting the two sites and promoting other points of interest within the territorial context, exploring the possibilities for sustainable archaeological tourism and transportation.

In the framework of these targets, the whole project dealt with three main research questions:

- Epistemological: how AI systems can foster territorial knowledge, both for the local community's awareness and for the dissemination of this knowledge to a wider public.
- Spatial: how to overcome the marginalization by making "intangible" socio-territorial resources visible and transforming perceived limits into strategic opportunities.
- Processual: how HI practices can generate more inclusive and context-aware planning outcomes.

In this regard, the INSITE's approach can be intended as a proposal for a shift from exclusive expert data to inclusive shared knowledge, where Hybrid Intelligence serves as the catalyst for territorial empowerment.

Starting from the INSITE experience and focusing on the innovative proposal, the following sections describe the design process used for the development of an AI-based chatbot designed to perform the dual function of an information interface and a facilitator of participatory processes.

3.2 The Central Phase: the "Heidy" Chatbot as Preliminary Result

The design of the "Heidy" chatbot (named after *Homo heidelbergensis*) was thought to address both dissemination goals and those of actively engaging the public, thus assuming the dual role of an informational interface and a conversational facilitator.

The modeling of "Heidy" was the focus of the digitization activities carried out within the project INSITE. Based on validated scientific sources (Aidonis et al., 2023; Mietto et al., 2021), the modeling (and subsequent animation) of *Homo heidelbergensis* was carried out, in line, from an anthropometric standpoint, with the characteristics of the trackmaker of tracks A and B at the "Ciampate del diavolo" (Zingariello et al., 2026) (Figs. 2 and 3).

Augmented reality applications have already been designed within the project INSITE for *in situ* visualization – both static and dynamic - of the "Heidy" three-dimensional model, aligned with broader strategies for territorial valorization and knowledge dissemination.

Although the ongoing research objective is to evolve "Heidy" into an AI-driven avatar representing *Homo heidelbergensis*, its current iteration is configured as a Google Gemini GEM, primarily functioning as a text-based chatbot.

To evaluate the efficacy of the "Heidy" prototype, this study delineates two methodological aspects: *a)* the construction of the knowledge domain as a process of semantic delimitation and epistemic organization of content, and *b)* the assumption of role as a strategy for configuring the chatbot's identity.

3.3 The Construction of the Knowledge Domain

A non-specialized chatbot tends to produce generic and inconsistent responses; for this reason, the construction of an explicit and delimited knowledge domain was fundamental to ensuring the correct functioning of "Heidy". The construction of the knowledge domain was defined through an in-depth not automated interpretative framework to ensure epistemic accuracy. This process required a rigorous systematization and translation of INSITE's results into a structured knowledge base.

The documentation supporting the knowledge domain was organized into discrete information chunks, that is, autonomous units of knowledge, designed to be self- sufficient. Each chunk addresses a specific micro-query, ensuring internal coherence and independence from other chunks. Thus, the content structure follows a Question & Answer (Q&A) framework, organized into knowledge clusters such as:

- the strategic objectives and structural framework of the INSITE project;
- representative case studies and empirical research outcomes;
- prototyped digital tools and technological applications developed;
- educational and participatory engagement initiatives;
- dataset deriving from end-users surveys.

With regard to the final point on the list, in order to complement the scientific dimension with an experiential and context-specific component, the perceptions and assessments expressed by local users have also been incorporated into the knowledge domain; these were gathered and organized on the basis of responses to questionnaires administered throughout the project.

For each topic, multiple chunks have been prepared, not repetitive but capable of addressing the subject from different perspectives, to facilitate information retrieval and overlay processes.

Understanding how to structure the various chunks and optimize their accuracy is the key to improving the effectiveness of the RAG (Retrieval-Augmented Generation) system supporting the chatbot (Moreno-Cediel et al., 2026).

Within the RAG framework, the system retrieves the most relevant content from the knowledge domain and incorporates it into the response, ensuring contextual consistency and adherence to reliable and verifiable information.

The structure of the chunks was also subject to an iterative validation process conducted by the research team, aimed at verifying both their semantic consistency and their effectiveness in supporting the generation of responses. In particular, the content underwent an internal review to ensure its scientific accuracy and relevance to the project's objectives, and was tested through simulations of interactions with the chatbot to evaluate the quality of the responses produced. This process enabled the identification of any ambiguities, redundancies or gaps in information, allowing for the progressive refinement of the chunk structure.

Finally, in addition to the chunks, which are essential for a rigorous systematization of content, a large series of documents produced during the project activities was uploaded to further expand and consolidate the knowledge domain (Fig. 4).

All sources, in accordance with the principle of transparency, are cited by "Heidy" and shared with users.

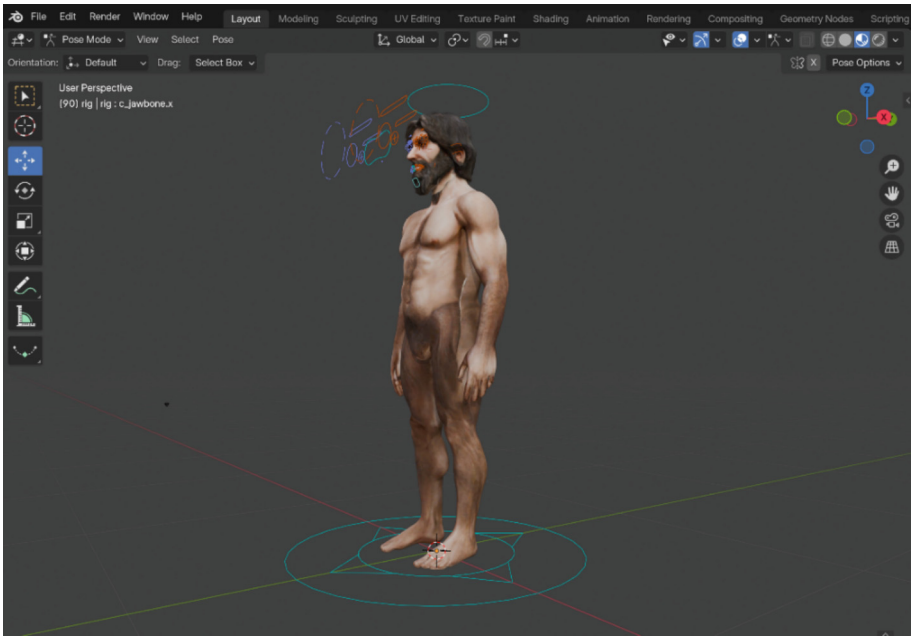

Fig. 2. Modeling and animation of the 3D model of 'Heidy' in Blender



Fig. 3. 3D model of "Heidy"

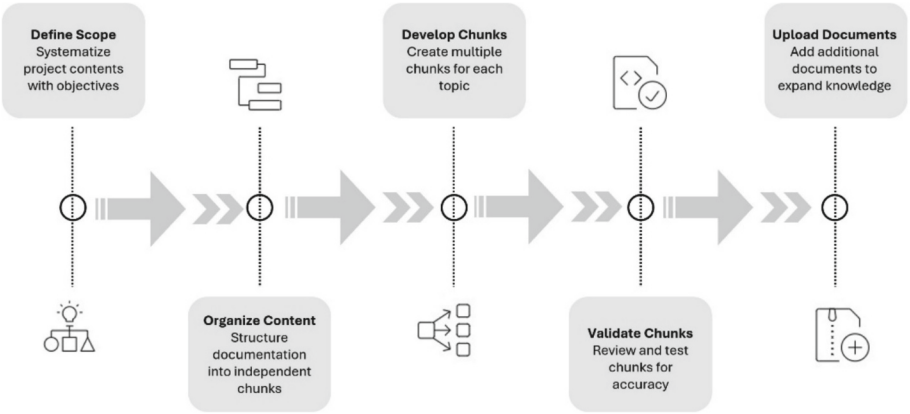

Fig. 4. The process for the construction of the knowledge domain

3.4 Assumption of Role

In parallel with the development of the knowledge domain, we proceeded to define the instructions necessary to characterize "Heidy" in her dual role as an information interface for the INSITE project (which provides answers) and a facilitator of participatory processes (which asks questions).

Although the two profiles required distinctly different instructions, a general definition of Heidy's identity was established that is common to both, defined by the following instructions: *a)* assume the role of "Heidy", a figure inspired by *Homo heidelbergensis*; *b)* introduce yourself as a spokesperson for the INSITE researchers; *c)* do not use an emphatic, promotional, or overly narrative tone; *d)* maintain a high level of scientific rigor in your explanations (Fig. 5).

To configure "Heidy" as an information interface, a series of instructions were defined regarding the type of language to use, the logical structure of the responses, and the priority to assign to the content.

An important part of the design involved defining the limits of competence; in this regard, "Heidy" was instructed to: *a)* declare the absence of information when necessary; *b)* not arbitrarily complete incomplete data; *c)* not simulating scientific authority on content not present in the project corpus; *d)* in the event of missing information, direct users to consult the project website (Fig. 6).

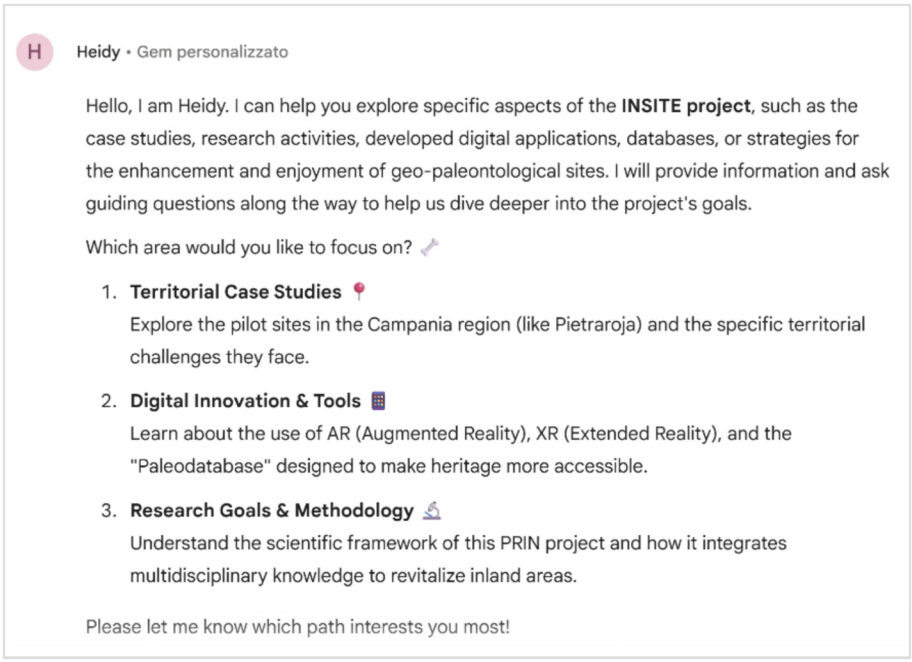

Fig. 5 How the "Heidy" chatbot introduces itself during the initial interaction

Subsequently, instructions were included on how to activate facilitator mode. Specifically, "Heidy" was instructed to activate facilitation if the user: *a)* shows interest in a particular topic*; b)* expresses an opinion or judgement; *c)* comments on the responses provided (Fig. 7).

It was essential to explain clearly some facilitation rules, including: *a)* ask only one question at a time; *b)* avoid generic questions out of context; *c)* do not insist if the user does not want to elaborate; *d)* adapt the level of the questions to the user's profile.

In this sense, "Heidy", acting as a facilitator, takes on the role of conversation initiator; it does not simply respond to the user's inputs, but actively shapes the interaction by guiding reflective processes through the formulation of targeted and progressive questions. This approach helps to bring to the surface perceptions and levels of awareness that are difficult to detect through direct questioning.

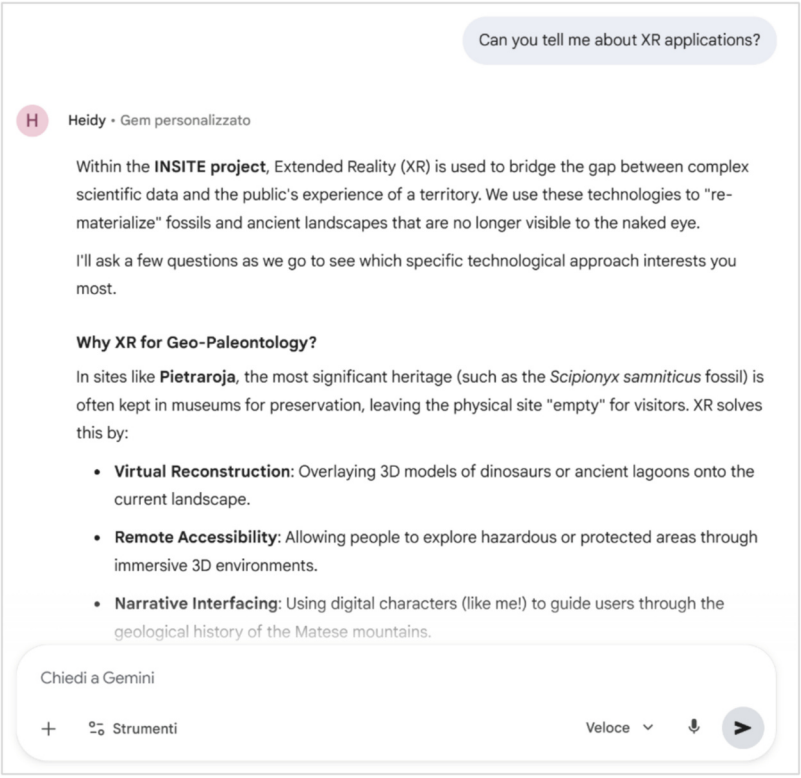

Fig. 6. "Heidy" in information interface mode

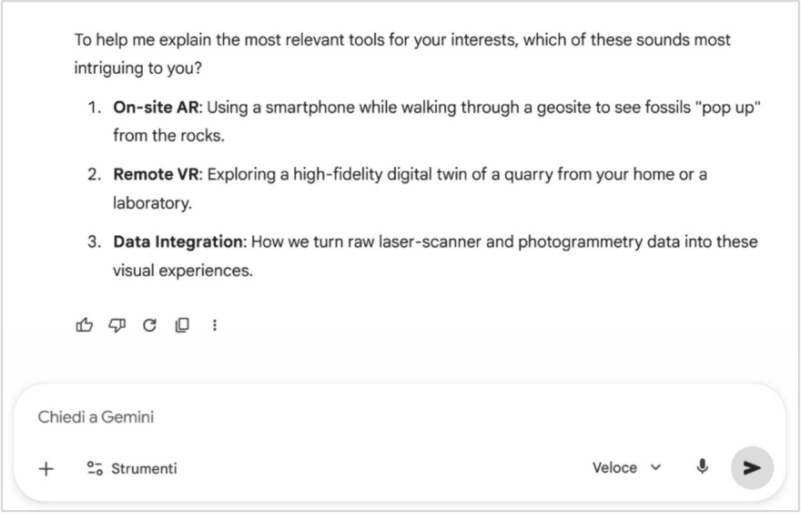

Fig. 7. "Heidy" in facilitator mode

4 Conclusions and Discussion

This paper proposed a reflection about the risk to privilege efficiency driven by the potentialities of AI especially in areas in which some important information that are relied on territorial identity context could be vanished.

It argues that Hybrid Intelligence, combining AI capabilities with participatory processes and local knowledge, provides a more inclusive and resilient alternative framework for design of regenerative planning of fragile areas like inner areas.

Findings from the INSITE project showed that even though in the presence of important cultural heritage the empowerment of local communities is fundamental to make people really part of this uniqueness, to involve them for the territorial promotion and thus, for the global success of regeneration design.

The experimental significance of "Heidy" lies in its capacity to integrate, within a single device, the dissemination of validated knowledge with a dialogic, generative interface, thereby promoting widespread reflexive awareness.

In this perspective, "Heidy" represents a pioneering application of Hybrid Intelligence in marginal contexts, where AI-mediated interaction facilitates both the democratization of knowledge and the active listening to territorial needs through innovative participatory modalities.

While the current research remains iterative, it contributes to enhancing the perceptual attractiveness of territories often excluded from conventional cultural circuits, supporting their revitalization within a competitive global landscape.

Based on our experience and findings, it appears to be a logical evolution of the ongoing work to proceed toward an initial visual and three-dimensional rendering of the chatbot as an embodied interface, aimed at enhancing its communicative recognizability and supporting more engaging forms of interaction with users, while simultaneously contributing to further implementing participatory processes.

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