Supporting Interdisciplinary Research with Cards-based Workshops - A Case Study on Participatory Planning for Mountain Pastoralism

Thibault Raffaillac, Nadia Boukhelifa, Emilie Crouzat, Fabien Stark, Jean-Pierre Müller, Jacques Lasseur

Supporting Interdisciplinary Research with Cards-based Workshops - A Case Study on Participatory Planning for Mountain Pastoralism

Thibault Raffaillac
thibault.raffaillac@inrae.fr
INRAE, SELMET, Univ. Montpellier, CIRAD, Institut Agro Montpellier, Montpellier, France

Nadia Boukhelifa
nadia.boukhelifa@inrae.fr
INRAE, AgroParisTech, Univ. Paris-Saclay, UMR 518 MIA Paris-Saclay, Palaiseau, France
ISCPIF, Paris, France

Emilie Crouzat
emilie.crouzat@inrae.fr
INRAE, Univ. Grenoble Alpes, LESSEM, St-Martin-d'Hères, France

Fabien Stark
fabien.stark@inrae.fr
INRAE, SELMET, Univ. Montpellier, CIRAD, Institut Agro Montpellier, Montpellier, France

Jean-Pierre Müller
jean-pierre.muller@cirad.fr
CIRAD, Campus Intl. de Baillarguet, Montpellier, France
UMR SENS, Univ. Montpellier, CIRAD, IRD, UPVM, Montpellier, France

Jacques Lasseur
jacques.lasseur@inrae.fr
INRAE, SELMET, Univ. Montpellier, CIRAD, Institut Agro Montpellier, Montpellier, France

ABSTRACT

Profound transformations are currently impacting the intricate relationships between human pastoral activities and Alpine mountain ecosystems. In this context, we were invited as human-computer interaction practitioners to join an interdisciplinary team, to reinforce the use of computer simulations in meetings with local stakeholders. However, due to the diverse nature of stakeholders involved and their interactions, the specific format of these meetings and the utilization of model simulations remained unclear. To clarify these uncertainties, we designed a cards-based ideation method to collectively plan participatory workshops and envisage if and how information technology tools could be integrated. In this paper, we present the design of our ideation method *Cards4Concertation* and two workshops that implemented it. We then reflect on our findings with lessons learnt both for designing cards-based activities for ideation within interdisciplinary teams, as well as visualizations for participatory planning and decision-making.

CCS CONCEPTS

• **Human-centered computing** → **HCI design and evaluation methods**; *Visualization application domains*; • **Applied computing** → *Agriculture*.

KEYWORDS

card game, concertation, visualization, ideation, interdisciplinary, socio-ecology, sustainability

CHI EA '24, May 11–16, 2024, Honolulu, HI, USA

ACM ISBN 979-8-4007-0331-7/24/05
https://doi.org/10.1145/3613905.3637107

ACM Reference Format:
Thibault Raffaillac, Nadia Boukhelifa, Emilie Crouzat, Fabien Stark, Jean-Pierre Müller, and Jacques Lasseur. 2024. Supporting Interdisciplinary Research with Cards-based Workshops - A Case Study on Participatory Planning for Mountain Pastoralism. In *Extended Abstracts of the CHI Conference on Human Factors in Computing Systems (CHI EA '24), May 11–16, 2024, Honolulu, HI, USA.* ACM, New York, NY, USA, 8 pages. https://doi.org/10.1145/3613905.3637107

1 INTRODUCTION

In the last few decades, mountain areas in the French Alps have been at the heart of profound changes that are disrupting the ecosystems around pastoralism. Climate change has increased pressure on biodiversity, fire risk and water distribution, reducing availability of forage and exacerbating the impacts of grazing on fragile landscapes. Increased tourist and residential activity has also accentuated conflicts over land access between the ever-growing number of users. At the same time, numerous research groups have emerged to explore interdisciplinary and action research approaches aiming to improve their impact on society [41]. In socio-ecological settings in particular, modelling processes have been widely used to facilitate the construction of a common system representation between researchers and local stakeholders, and to enable the study of system dynamics through simulation and visualizations [1].

In this context, we were invited as Human-Computer Interaction (HCI) practitioners to join an action research project called *Pastofutur*, which studies the adaptation of pastoral practices to contemporary evolution affecting 41 municipalities in the French Alps. The project is composed of ten researchers working in different domains such as organizational sciences, public policy, ecosystem services, and computer modeling; and in close collaboration with stakeholders including regional council members, forest managers, shepherds, etc. *Pastofutur* has been running for the last two years, during which multiple meetings, we call *concertations* [22], were held with and without stakeholders to share information, understand different viewpoints and plan actions. We note the focus of the project on participatory planning [15] in contrast to actual

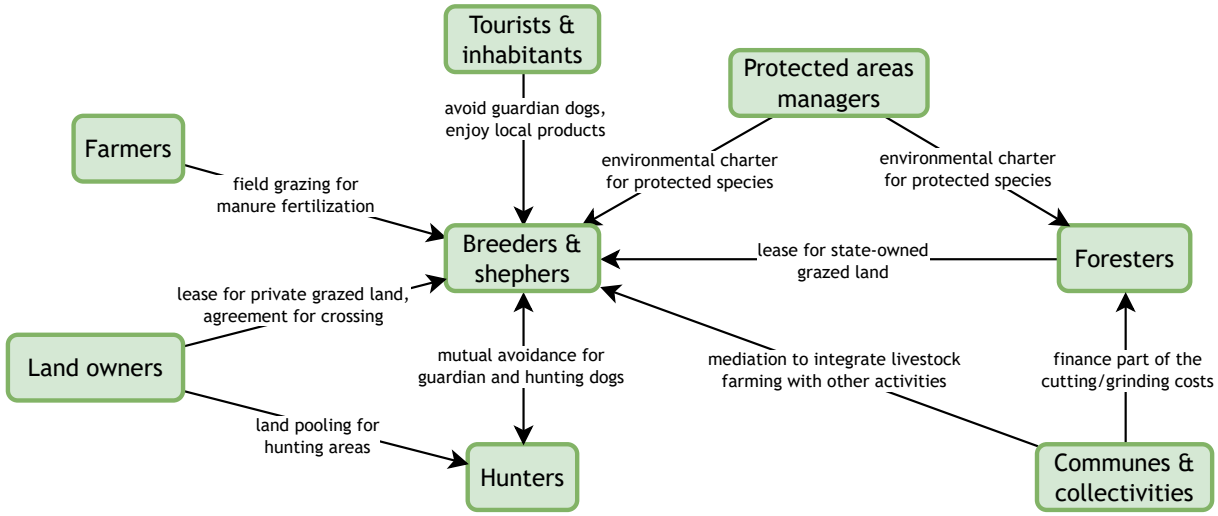

Figure 1: Simplified overview of the stakeholders in the socio-ecosystem under study, and their interactions

decision-making which may take place outside the concertation meetings in which we are involved.

Our initial task in *Pastofutur* was to support the interactive use of a multi-agent model during concertations with local stakeholders, for collectively exploring the future of pastoral territories [34]. The need for HCI was established by the research team members who found that despite their popularity, data-driven tools and computational models were frequently put aside during meetings with stakeholders, often wasting months of work on analyzing and reporting on socio-ecosystems [9, 23, 25]. Their hypothesis was that ad-hoc human-computer interfaces and interactive visualization techniques could motivate participants to draw more insights out of simulation models. Nevertheless, during the course of the project, we observed that even researchers and stakeholders who had an initial interest in Information Technology (IT), including visualization and simulation tools, had difficulty projecting themselves onto both the *relevance* and *forms* of these tools. Indeed, without a clear vision of user needs, the risk was to abandon the use of models and data visualizations in concertation meetings, despite the abundance of prior work supporting their role in improving communication between stakeholders [42, 43, 45] and aiding decision-making [17]. Our research question was thus: *What IT tools can support concertation meetings in a socio-ecological context?*

To meet the dual need to ideate which forms of IT to use in meetings and to inform colleagues on the options available, we chose to design a card game to imagine future concertation meetings with stakeholders, *Cards4Concertation*. The cards listed categories of design choices including meeting types and objectives, categories of participants, methods of concertation [11], data sources, and visualization types and user interactions [5]. Participants could freely arrange and annotate these cards, enabling them to envision a diverse range of scenarios. Using two iterations of *Cards4Concertation*, we conducted two workshops with seven and eight participants, which in turn helped to strengthen the group dynamics and clarify the future directions of the project.

This paper outlines three main contributions to the interdisciplinary research project *Pastofutur*: an ideation design method called *Cards4Concertation*; two workshops using this method; and lessons learnt and reflections on designing ideation cards and visualizations for concertation meetings. Our findings are relevant to the wider HCI community as they contribute insights on ideation methods for group collaboration [2, 33], and on the use of visual information for grounding and consensus building in computer-supported cooperative work [8, 16, 26].

2 BACKGROUND AND CONTEXT

Our research setting is the *Alpes Provence Verdon* community of 41 communes, in the Verdon region of southeastern France. It spans 1,718km² for 11,422 inhabitants, making it one of France's least densely populated areas. Given our focus on the multi-use of pastoral areas, the network of key stakeholders and their interactions is summarized in figure 1. In this context, the role of pastoral farming is facing growing scrutiny due to its conflicts with other activities such as tourism, forestry, environmental conservation, and economic development.

Our project *Pastofutur* started in 2021, to help support the evolution of pastoralism by analyzing its interactions with other activities through the concept of multi-functionality. An interdisciplinary team from two applied research institutes in France (INRAE and CIRAD) came together, with the aim to accompany local stakeholders in an action-research approach. Computer scientists joined the project to contribute through multi-agent modeling and simulation, a common practice in agricultural governance projects [12]. The Verdon setting was selected since prior projects were conducted in the same area, as such many important contacts with key institutional figures were already established.

A central aspect of *Pastofutur* is the involvement of its researchers in regular *concertation* meetings with stakeholders. Similar to [22] we borrow the term 'concertation' from French as there is no exact equivalent in the English language. Arnstein [3] distinguishes

concertations from related terms such as *consultation* by how far the output of these processes are from the final decision-making. Whereas consultation is more focused on sharing and understanding of participants' opinions, concertation often happens at later stages, involving a number of impacted parties to collectively develop actionable proposals for a project. In both cases however, the goal is not necessarily to reach a final decision, but rather to prepare or plan for it, through dialogue, confrontation of different view points, definition of shared objectives and development of new ideas [11].

Our main effort in the *Pastofutur* project is to better characterize the human-computer interfaces and visualizations that could meet the project's goals and needs of our stakeholders before proceeding with their development. Determining the kind of tools to build proved to be challenging as the role of IT during concertations was yet to be defined. To clarify this role, we experimented with many methods such as: writing a formal specification of features for a graphical interface; building a mock-up of an interface on top of an agent-based model [34]; carrying out and analyzing interviews with stakeholders; helping other researchers design diagrams of stakeholders' interactions; and organizing two cards-based workshops to imagine future concertations with stakeholders, which we detail in this paper.

3 RELATED WORK

A variety of methods can be used to facilitate concertations, some relying on extensive use of IT while others not. These methods include formal presentations, surveys and questionnaires, focus groups, role play, and participatory modelling. Role play methods for instance are not necessarily IT-based, but allow participants to gain perspective, address sensitive questions and explore more creative choices, unburdened by the constraints of real-life scenarios [11]. They also allow participants to step into the shoes of others, particularly in scenarios involving role reversals, leading individuals to experience the challenges and needs of others and fostering empathy [11].

Among the widely used IT-based concertation methods is participatory modeling [13, 46]. It consists of combining concertation with modeling where a group of experts and stakeholders work together to model and simulate different scenarios. This modeling method may be based on role games or computer simulations, but in both cases it follows four iterative stages: context and stakeholder analysis, model development, model simulation, and discussion of results.

We were inspired by these methods, namely role play and cards-based methods, to design *Cards4Concertation* which we describe in more detail in sections 4 and 5. Below we discuss work that is most pertinent to our case study contributions, namely the use of cards in socio-ecological contexts and visualization methods in participatory settings.

3.1 Use of cards in socio-ecological contexts

Card games have been used extensively in various forms in socio-ecological contexts. With Lauracle [37], for example, Thénard et al. used a card game to explore the levers of autonomy for forage farming systems, by letting participants play the different levers as cards against different issues, then vote for the best cards. Felt et al. [14] developed the card-based engagement method IMAGINE to foster citizen debates about the emergence of nanotechnology, where each participant would create scenarios by selecting prospective contexts, applications of nanotechnologies, potential issues and future public reactions. The Phylo trading card game [6] was designed like the Pokemon game, to promote biodiversity awareness. It was shown to improve recall of species and raise ecological sensitivity, and has been used extensively as a teaching tool.

Besides, customizable card games are uncommon in the literature. Only a few entries are referenced in Wölfel & Merritt's review of card-based design tools [47], and the notion is even absent in Roy & Warren's review [35]. Moreover, the degree of customization is often limited to the option of adding new cards, rather than editing existing cards or offering flexible rule modifications, all of which are fundamental attributes of *Cards4Concertation*.

3.2 Use of visualization in participatory settings

Visualization has been successfully applied to the concerted management of various types of natural resources, particularly through discussions and model simulations. Most of these visualizations tend to be static, in 2D or 3D. For example, Mora et al. [28] used scenarios and 2D visualization to help explore the possible future of the global food system. Schroth et al. [39] implemented a 3D landscape visualization to represent various scenarios of landscape change. Lewis et al. [24] provided a 3D visualization which they claim was able to provide common ground between different cultural groups in forestry. However, only a few studies looked at the impact of such visualizations on the concertation process. Hayek et al [19] compared 3D and abstract visualization for participatory planning tasks and found different benefits for using them in participatory workshops. Similarly, Tobias et al. [43] conducted participatory workshops with and without visualization and found that the visualizations they implemented provided a better common basis for communication, but only marginally inspired participants to develop new ideas. They also found these visualizations distracting as the discussions were drawn towards their visual aspects. These different findings suggest the need for more investigations to study the impact of different types of visualizations in participatory planning contexts.

4 WORKSHOP I: STAKEHOLDERS, OBJECTIVES & PARTICIPATION LEVEL

When considering the design of IT tools for *Pastofutur*, we noted that the nature of meetings with stakeholders was not clearly defined. As a result of the unfamiliarity with IT, most of our colleagues had no a priori ideas on how such meetings would unfold in the context of IT. We thus designed an ideation method that could provide participants with initial choices while still leaving space for creativity. Accordingly, we opted for a cards-based workshop that became a pilot iteration of *Cards4Concertation*. Seven researchers from the *Pastofutur* project took part in this workshop, in a meeting that lasted an hour and a half.

Figure 2: Pictures showing the organization of two groups from workshop I and their final meeting proposals

4.1 Setup and procedure

We designed a card game to help users design future participatory meetings with stakeholders. The design of the cards was based on *Workshop Design Cards* by OSF [32] and was grounded on three goals: (i) the need to provide a wide range of options to foster creativity, (ii) the ability to combine different choices to generate new meetings, and (iii) a playful element to encourage engagement. Our initial design featured 5 decks, having a total of 38 cards (see figure 2 and supplementary material for more detail):

- Stakeholders listing the groups of people to invite to the participatory meetings (e.g. farmers, foresters, tourists)
- Expected results listing different possible outcomes or objectives (e.g. "*The participants made decisions on ...*")
- Configurations listing spatial arrangements of persons and groups (e.g. one-to-one, in sub-groups)
- Activities to be carried out to achieve the expected results (e.g. debating, voting, planning)
- Supports (IT and non-IT) that would be used to display information (e.g. tabletop screen, paperboard, tablets)

Each card included a deck label, a card title, an illustration image, an optional description, and a space for commenting. Similar to *Inspiration Card Workshops* [18], we included comment spaces to let participants appropriate the cards by refining them, and suggesting modifications for future versions. Blank cards were also provided for this purpose. We intentionally did not provide participants with a cardboard having placement grid lines, drawing on the mixed feedback it received in *Tiles* [29]. Instead, participants were able to freely place their cards in the available table space.

We gave participants the following instruction for their ideation activity: "*imagine all the situations (meetings or events) that we [researchers] could be involved in to accompany stakeholders in Pasto-futur*". At this point we did not mention concertations because we considered all types of meetings including consultation and decision-making. We suggested to participants to use the cards in the order presented above, while highlighting that doing so was entirely at their discretion. The workshop consisted of three phases: 10 minutes to explain the purpose of this workshop and to form two groups; 50 minutes to ideate with the cards provided and write a short summary of their meeting design; and 25 minutes to report back to the group. Additionally, there was a 10 minutes general discussion to rate the cards activity.

4.2 Results

Each group designed their next meeting with the stakeholders that they were able to identify (both meeting proposals are shown in figure 2). Participants effectively used the Stakeholders deck to map out and discuss the stakeholders involved in the study. Interestingly, the Expected results revolved more around sharing information and viewpoints than making decisions, which incited us to focus specifically on concertations for the next workshop rather than consultation or actual decision-making. The general feedback from participants about *Cards4Concertation* was overall positive. They found the activity very engaging and relevant to hold with actual stakeholders. Moreover, their feedback helped us refine our cards, specifically: we renamed Stakeholders to Participants to include both researchers and stakeholders; we replaced Expected results with Objectives that were then expanded from [21]. Since we would now focus on concertations as a specific type of participatory meetings, we created a new deck called Methods for concertations [11]. We also added a new deck on Social terrain to help guide the choice of concertation methods based on known social issues (e.g. intense controversy surrounding the presence of wolves), and three decks related to the use of IT (see next section: Data Sources, Visualizations, Interactions).

5 WORKSHOP II: EXPLORING THE ROLE OF IT & VISUALIZATION FOR CONCERTATION

The first workshop allowed us to validate the required level of participation (i.e. concertation), the suitability of a card game among our team and for stakeholders, and the various objectives of these concertation meetings (see the supplementary material for the actual cards). Nevertheless, while our researcher colleagues were mostly focused on analyzing the socio-ecosystem, they had no clear IT requirements for concertations and so the design space was still very large. We thus organized a new workshop to better understand the role of IT in concertations. We explored this question by focusing on the choice of visualizations.

5.1 Setup and procedure

We designed six new card decks and renamed one (81 cards in total) while also switching to a color-blind safe palette [44]:

- Participants renamed from Stakeholders with cards updates following the initial workshop

Figure 3: Pictures showing the organization of both groups and their final proposals during workshop II. The image on the right illustrates the appropriation of a card by writing, as a description was rewritten by a group despite being already on the card.

- Objectives replacing Expected results, adapted from [21] (e.g. share information, gather feedback)
- Social terrain listing positive-negative dimensions of relationships (e.g. consensual or controversial topic)
- Methods for concertations listing all the types of meetings referenced in [11] (e.g. formal presentation, role play)
- Data Sources such as satellite imagery, simulation data, qualitative surveys, and participant feedback
- Visualizations from dataphys.org and [30] to encourage creativity and diversity (e.g. 2D/3D charts, maps)
- Interactions listing user interactions inspired from [5, 40] (e.g. select, zoom, filter, annotate)

We held this workshop during a quarterly in-person research seminar. Six of the eight participants had taken part in the previous workshop, so we asked them to review the new cards before they went to print. The instruction that was given to participants was to brainstorm around a hypothetical scenario where visualizations are used in an ideal *Pastofutur* concertation meeting. More specifically they were prompted to think about this question: "*What role can computer visualizations play in concertation sessions?*".

We had two hours to run the workshop, divided into four phases: 20 minutes to form groups (A & B) and introduce the activity (explaining the research question, defining our notion of concertation and suggesting an order for processing card decks), 50 minutes of ideation with regular reminders of the remaining time, 40 minutes to report on each group's proposal and provide feedback on the cards activity, and 10 minutes for a post-workshop questionnaire. The latter included a first set of demographic questions, followed by questions about (i) the main challenges encountered during concertation meetings, both as participants and as facilitators, (ii) the role of IT for supporting participants and facilitators during these meetings, and (iii) any feedback on the workshop.

The data we collected during this workshop include: (i) photographs of the ideation phase to illustrate the participants' working methods, (ii) an audio recording of the reporting phase, and (iii) the completed questionnaires.

5.2 Participants

From the eight participants who attended workshop II, seven were researchers and one was an engineer. There were four males, four females, each from a different domain but all sharing interest in pastoralism (organizational sciences, sociology of mountain territories, participation and socio-environment, mountain and pastoral socio-ecosystems, livestock systems, socio-economics and evaluation of public policies, zootechnics, multi-agent modeling and complex systems). Half the participants had over 20 years of domain experience, the other had on average 9.5 years of experience in their respective domains. Familiarity with IT tools varied between participants from novices (2), intermediate (4), to advanced (2). They all had substantial experience in both participation as well as facilitation of past concertation meetings (Facilitation: multiple times a year (6), multiple times a month (1), multiple times a week (1); Participation: multiple times a year (4), every 1 to 5 years (2), multiple times a month (1), multiple times a week (1)).

5.3 Analysis and results

The audio recording was transcribed using OpenAI's Whisper [31], and together with the questionnaire they were coded independently by two researchers following a thematic analysis approach [4]. The themes that emerged were then pooled and discussed in online meetings between the two coders. The results described in section 5.3.1 are from the reporting phase of the workshop, while those reported in sections 5.3.2 and 5.3.3 come from the questionnaire data (we include the number of participants between brackets). Participants' quotes were translated from French into English.

5.3.1 ***Using cards to describe concertation meetings.*** When analyzing the audio recording, we focused on two aspects: (i) differences between the verbal reports and the cards, to understand how accurately the cards reflected the proposals of the groups; and (ii) cards improvements for future revisions as suggested by participants. The two groups' proposals are shown in figure 3.

When presenting their proposed meeting, each speaker mainly read the cards in a predetermined order, adding examples orally or sometimes describing the debate that had accompanied the choice of a card. While the hierarchical arrangement of cards on the table was not always immediately evident, participants had no trouble verbally articulating it. When the oral description provided a clarification not mentioned on a card, it was most often implied and obvious to the group (e.g. P2 - "*slightly unbalanced powers [...]* ***between breeders and the rest of the stakeholders***", the text in bold

being absent from any card). Occasionally, the group mentioned a detail that could not be expressed with the cards, in particular the expression of time and duration. In addition, some cards were kept aside for other needs (e.g. P4 - "*doing an interest-power analysis of stakeholders would be super important for our team, and we haven't done it yet*").

We noted that each group reasoned at least partially about the more general concertation process. One group was putting cards aside for other meetings, while the other had in fact imagined a multi-day seminar with several phases. Participants mentioned that the cards enabled them to design for the concertation process as a whole, rather than just for individual meetings. They also appreciated that the cards explicitly separated concertation methods from visualizations, giving them the freedom to explore methods that might not depend on IT. As an area for improvement, participants reported a slight discomfort with the Social Terrain deck, due to their limited prior knowledge of this aspect, and the difficulty to reason with cards presenting positive-negative continuums instead of positive and negative cards.

5.3.2 ***Perception of main challenges and role of IT during concertations.*** The main challenges identified in the questionnaire, which were common to both participants and facilitators, were the inclusiveness of divergent viewpoints and mutual understanding of people (7), and the expression of all participants on a balanced basis (6). Other challenges specific to facilitators were process flexibility to adapt to the context (2), clarity of expression (2), management of conflicts during meetings (2), and the reconciliation of divergent interests among participants and/or facilitators (2).

IT was mainly cited as a facilitator of mutual understanding for participants (4), and as a means of expressing participants' points of view (3). For facilitators, IT was cited as a means of providing multiple representations (2). However, two conditions were set for the use of IT in concertations: that it retained a supportive role and remained dismiss-able (3), and that technology was flexible enough to adapt to people and the concertation process (3).

5.3.3 ***Specific IT & visualization needs for concertations.*** Throughout the second workshop, participants provided requests for specific tools as well as more general design constraints. Here we summarize them with four proposals spanning different goals of concertations. These proposals are not meant to be exhaustive, but rather to serve as concrete opportunities for future work.

In-situ and tailored visualizations of simulation results - One of the main requests from group B was to address the issue of readability of visualizations. This was likely due to the varying levels of familiarity among participants with the charts presented on the cards (and IT in general, see section 5.2): P8 - "*there is a need for real training of stakeholders to understand what these charts say*". The request here was to tailor the visualization of simulation results to a variety of representations that stakeholders are familiar with, such as topographical maps, landscape photographs and embossed maps; and to quickly adapt these representations to people' levels of expertise.

Interactive knowledge map for world cafés - Group A explicitly requested assistance in reporting and organizing the contributions from different groups during a world café, as noted in P2 - "*an interactive report like a cognitive map, all together, shared with the World Café*". The proposed interactions included generating diagrams, sketching and commenting, zooming out for overviews and in for details, comparing diagrams between groups, and freely linking elements.

Tools for participatory mapping - Group B expressed a specific need for participatory mapping to simulate what-if scenarios: (P8 - "*participatory mappings [...] can be used to build mutual understanding, and at the same time to enable us to project ourselves, like if we do that, what happens*"). Indeed, printed maps are often used during interviews and meetings, to collectively document routes and delineate areas. However, the added information on these maps is not always accurate, as it is often hand drawn or dictated orally by someone else. These interactions could be enhanced with digital drawing tools, which would improve the accuracy of the collected information [20].

Ambient multi-sensory visualizations - A suggestion from group B relates to the emergence of 'sensitive approaches' between art and science, that leverage non-visual artefacts to help people discover new perspectives on familiar places (P8 - "*hearing the barking of patous [shepherd's dog] or things like that, to create really sensitive hooks somehow to what people are doing, what people are experiencing*"). Auditory cues and physical textures could be used in particular, to let participants get a more intimate experience of other stakeholders' viewpoints, and to help stakeholders express their impressions of the field by forming their own soundscape or haptic environment [27].

6 DISCUSSION & LESSONS LEARNT

The use of a card game was very effective to bring the perceptions of team members into discussion, to elicit their feedback on various choices, and to help resolve future uncertainties. However, it was somewhat inadequate for conveying social aspects and was viewed as overemphasizing IT in concertations. Furthermore, we have yet to apply the cards in other socio-ecological projects, with actual stakeholders, and assess the usefulness of its key design decisions. In what follows we reflect on the findings gleaned from both workshops, and discuss lessons learnt and reflections on ideation cards (L1–3) and designing visualizations (L4–6) for concertations.

L1: Adapting the cards to the context and progress - The cards we designed between the two workshops were in fact very different. Whereas the first workshop was dedicated to the planning of concertation meetings, the second focused on the support of computer visualizations. The choices of cards, decks and even the instructions given to participants therefore evolved between the two sessions. Some cards, such as the stakeholders, were designed specifically for our case study and would not be suitable for other cases. Moreover, they represented our own choices for participants to assess, without being forcibly exhaustive. An essential point is thus to adapt the card game to the progress of the project, to its context, to the participants of the workshop and to its organizers (who are often the researchers). With this in mind, further research is needed to study how *Cards4Concertation* could be applied to other projects. We plan to make a kit with many optional decks to include based on the context at hand, and to ease the editing of cards by providing editable vector files.

L2: Imprecision as a design dimension - Writing on the cards was instrumental in getting the groups to appropriate them. They always worked in two phases: an appropriation phase during which they acknowledged the cards and wrote on them, followed by a selection phase. Blank spaces encouraged participants to complete them where necessary. Throughout the group oral reporting, we noticed that cards annotated by participants frequently came with additional, more detailed verbal explanations. This led us to conclude that we should actively promote and encourage participants to write on cards. With this in mind, it seemed to us that the degree of precision of the cards influenced the tendency to write on them (figure 3). Our cards need to be precise enough to effectively communicate the scope of each deck's choices and facilitate the introduction of new cards within that domain, while being vague enough to encourage participants to engage with and modify them through comments and amendments.

L3: Complementing cards with other expressive means - During the workshops, links and hierarchies between cards were often only partially expressed by the relative positions of cards on the table, especially when the positions were already meaningful (e.g. chronology, being part of the same deck). Although we are unsure whether participants were satisfied with this limited expressiveness, for future iterations we plan to introduce various tokens to place on the cards, to form families between cards with similar tokens. Furthermore, although representing the social landscape proved challenging with cards, it would be interesting to consider assigning participants roles inspired by the six thinking hats [10], and addressing this topic at a later stage in the workshop, once a meeting has already formed.

L4: Visualizations for an iterative process rather than for a single meeting - Although our participants were instructed to design an 'ideal' concertation meeting, they were more interested in designing the overall concertation process. Our visualization tools thus need to account for the whole process including context and stakeholder analysis, and the actual debriefing and discussion of results, adapting their content and formats to these different stages. A particular challenge to consider is the multilevel starting points and potential destinations of concertations [7]. Provenance logging and related visualization techniques may be used to track this complex process and represent it to participants in a coherent and acceptable format (e.g., for privacy), providing not only details about the various exchanges and their stages, but also at a higher level an overall picture of the group consensus and its evolution [26].

L5: Visualizations that complement the debate rather than distract from it - Although participants requested different forms of visualization and interactions that go with them, they all expressed the importance of human-human communication especially at early stages of concertations. These visualizations should be flexible, adaptable to context, and importantly easily 'dispensable' as to not distract from the human-human activity. This could be achieved by providing physical forms of visualization, in 2D or 3D format, or even as ambient visualizations. The latter can rely on multi-sensory channels to engage participants and induce empathy [38]. We note that the exact form of these visualizations and their place with regards to the meeting facilitator or participants is an important question and is yet to be explored in future studies.

L6: Visual literacy considerations - Concertation meetings unite stakeholders that often have different types of domain knowledge, expertise and IT skill levels. Creating visualizations for such diverse skills is a challenge as an assessment of visual literacy is often not available prior to the concertation process. Aiming for familiar types of visualizations may help reduce the learning curve, but training participants to read more advanced forms of visualization (e.g., for complex simulation data) may also be needed even as part of the concertation meeting itself. Further research is needed to determine the most suitable formats for training in a concertation context (e.g., by analogy [36]), the stage of concertation at which this training is more effective, and how to adapt it to later stages of concertation.

Limitations - Similar to other qualitative and empirical work, our case study is bound by the context of the *Pastofutur* project, and thus we are not making claims for generalization of our findings. Instead, we provided details on the context of the *Pastofutur* project as an example of many comparable interdisciplinary projects where multiple types of users and stakeholders need to work together to build common ground, clarify objectives and potential IT requirements, in order to plan for joint actions and decisions.

7 CONCLUSIONS

We presented a case study based on an interdisciplinary research project aiming to support concertations in the context of mountain pastoralism. We designed *Cards4Concertation* with a dual purpose. On the one hand, they serve as an ideation tool to assist researchers in effectively planning future concertations that align with their needs. On the other hand, they enable the collection of user requirements for computer-supported meetings, which may include model simulations and advanced visualizations. Our intuition is that by including stakeholders and researchers in planning those meetings, engagement and consensus may be improved. Further research is needed to confirm or refute this intuition such as by comparing the 'quality' and outcomes of the planned concertations. Moreover, we will further explore the design space of interactive visualizations and simulation techniques, adapted to concertation. Our approach will consider insights found from the two workshops discussed in this paper, on designing for an evolving and iterative process, the importance of discrete and dispensable visualizations, and the visual literacy levels of stakeholders.

ACKNOWLEDGMENTS

This research was supported by the #DigitAg convergence institute and INRAE's Biosefair metaprogram.

REFERENCES

[1] Géraldine Abrami, William's Daré, Raphaëlle Ducrot, Nicolas Salliou, and Pierre Bommel. 2021. Participatory Modelling. In *The Routledge Handbook of Research Methods for Social-Ecological Systems*. Routledge, London.
[2] Marine Agogué, Kevin Levillain, and Sophie Hooge. 2015. Gamification of creativity: exploring the usefulness of serious games for ideation. *Creativity and innovation management* 24, 3 (2015), 415–429.
[3] Sherry R Arnstein. 1969. A ladder of citizen participation. *Journal of the American Institute of planners* 35, 4 (1969), 216–224.
[4] Virginia Braun and Victoria Clarke. 2021. *Thematic Analysis: A Practical Guide* (1er édition ed.). SAGE Publications Ltd, Los Angeles London New Delhi Singapore Washington DC Melbourne.

[5] Matthew Brehmer and Tamara Munzner. 2013. A Multi-Level Typology of Abstract Visualization Tasks. *IEEE Transactions on Visualization and Computer Graphics* 19, 12 (Dec. 2013), 2376–2385. https://doi.org/10.1109/TVCG.2013.124

[6] Megan M. Callahan, Alejandra Echeverri, David Ng, Jiaying Zhao, and Terre Satterfield. 2019. Using the Phylo Card Game to Advance Biodiversity Conservation in an Era of Pokémon. *Palgrave Communications* 5, 1 (July 2019), 1–10. https://doi.org/10.1057/s41599-019-0287-9

[7] Dawn Chatty, Stephan Baas, and Anja Fleig. 2003. *Participatory Processes towards Co-Management of Natural Resources in Pastoral Areas of the Middle East.* FAO, Rome.

[8] Herbert H. Clark and Susan E. Brennan. 1991. Grounding in Communication. In *Perspectives on Socially Shared Cognition.* American Psychological Association, Washington, DC, US, 127–149. https://doi.org/10.1037/10096-006

[9] Andrew Crooks, Christian Castle, and Michael Batty. 2008. Key Challenges in Agent-Based Modelling for Geo-Spatial Simulation. *Computers, Environment and Urban Systems* 32, 6 (Nov. 2008), 417–430. https://doi.org/10.1016/j.compenvurbsys.2008.09.004

[10] Edward de Bono. 1999. *Six Thinking Hats.* Back Bay Books, New York.

[11] Mathieu Dionnet, Amar Imache, Elsa Leteurtre, Jean-Emmanuel Rougier, and Aleksandra Dolinska. 2019. Guide to public participation and facilitation.

[12] Bruce Edmonds, Christophe Le Page, Mike Bithell, Edmund Chattoe-Brown, Volker Grimm, Ruth Meyer, Cristina Montañola-Sales, Paul Ormerod, Hilton Root, and Flaminio Squazzoni. 2019. Different Modelling Purposes. *Journal of Artificial Societies and Social Simulation* 22, 3 (2019), 6.

[13] Michel Étienne (Ed.). 2014. *Companion Modelling: A Participatory Approach to Support Sustainable Development.* Springer Netherlands, Dordrecht. https://doi.org/10.1007/978-94-017-8557-0

[14] Ulrike Felt, Simone Schumann, Claudia G Schwarz, and Michael Strassnig. 2014. Technology of Imagination: A Card-Based Public Engagement Method for Debating Emerging Technologies. *Qualitative Research* 14, 2 (April 2014), 233–251. https://doi.org/10.1177/1468794112468468

[15] John Forester. 1999. *The Deliberative Practitioner: Encouraging Participatory Planning Processes.* Mit Pr, Cambridge, Mass.

[16] Darren Gergle, Robert E Kraut, and Susan R Fussell. 2013. Using visual information for grounding and awareness in collaborative tasks. *Human–Computer Interaction* 28, 1 (2013), 1–39.

[17] Francisco Gutiérrez, Nyi Nyi Htun, Florian Schlenz, Aikaterini Kasimati, and Katrien Verbert. 2019. A Review of Visualisations in Agricultural Decision Support Systems: An HCI Perspective. *Computers and Electronics in Agriculture* 163 (Aug. 2019), 104844. https://doi.org/10.1016/j.compag.2019.05.053

[18] Kim Halskov and Peter Dalsgård. 2006. Inspiration Card Workshops. In *Proceedings of the 6th Conference on Designing Interactive Systems.* ACM, University Park PA USA, 2–11. https://doi.org/10.1145/1142405.1142409

[19] Ulrike Wissen Hayek. 2011. Which is the appropriate 3D visualization type for participatory landscape planning workshops? A portfolio of their effectiveness. *Environment and Planning B: Planning and Design* 38, 5 (2011), 921–939.

[20] ISPM. 2018. Software & Tools.

[21] Sam Kaner. 2014. *Facilitator's Guide to Participatory Decision-Making* (3rd edition ed.). Jossey-Bass, San Francisco, Calif.

[22] Sophie Labbouz, Bernard Roy, Youssef Diab, and Michel Christen. 2008. Implementing a public transport line: multi-criteria decision-making methods that facilitate concertation. *Operational Research* 8 (2008), 5–31.

[23] Ju-Sung Lee, Tatiana Filatova, Arika Ligmann-Zielinska, Behrooz Hassani-Mahmooei, Forrest Stonedahl, Iris Lorscheid, Alexey Voinov, J. Gareth Polhill, Zhanli Sun, and Dawn C. Parker. 2015. The Complexities of Agent-Based Modeling Output Analysis. *Journal of Artificial Societies and Social Simulation* 18, 4 (2015), 4. https://doi.org/10.18564/jasss.2897

[24] John L Lewis and Stephen RJ Sheppard. 2006. Culture and communication: can landscape visualization improve forest management consultation with indigenous communities? *Landscape and urban planning* 77, 3 (2006), 291–313.

[25] C M Macal. 2016. Everything You Need to Know about Agent-Based Modelling and Simulation. *Journal of Simulation* 10, 2 (May 2016), 144–156. https://doi.org/10.1057/jos.2016.7

[26] Narges Mahyar, Weichen Liu, Sijia Xiao, Jacob Browne, Ming Yang, and Steven P. Dow. 2017. ConsesnsUs: Visualizing Points of Disagreement for Multi-Criteria Collaborative Decision Making. In *Companion of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW '17 Companion).* Association for Computing Machinery, New York, NY, USA, 17–20. https://doi.org/10.1145/3022198.3023269

[27] Madeleine Manyoky, Ulrike Wissen Hayek, Kurt Heutschi, Reto Pieren, and Adrienne Grêt-Regamey. 2014. Developing a GIS-Based Visual-Acoustic 3D Simulation for Wind Farm Assessment. *ISPRS International Journal of Geo-Information* 3, 1 (March 2014), 29–48. https://doi.org/10.3390/ijgi3010029

[28] Olivier Mora, Chantal Le Mouël, Marie de Lattre-Gasquet, Catherine Donnars, Patrice Dumas, Olivier Réchauchère, Thierry Brunelle, Stéphane Manceron, Elodie Marajo-Petitzon, Clémence Moreau, Marc Barzman, Agneta Forslund, and Pauline Marty. 8 juil. 2020. Exploring the Future of Land Use and Food Security: A New Set of Global Scenarios. *PLOS ONE* 15, 7 (8 juil. 2020), e0235597. https://doi.org/10.1371/journal.pone.0235597

[29] Simone Mora, Francesco Gianni, and Monica Divitini. 2017. Tiles: A Card-based Ideation Toolkit for the Internet of Things. In *Proceedings of the 2017 Conference on Designing Interactive Systems.* ACM, Edinburgh United Kingdom, 587–598. https://doi.org/10.1145/3064663.3064699

[30] Ellie Nasr-Azadani, Denice H. Wardrop, and Robert P. Brooks. 2023. Pathways for the utilization of visualization techniques in designing participatory natural resource policy and management. *Journal of Environmental Management* 333 (May 2023), 117407. https://doi.org/10.1016/j.jenvman.2023.117407

[31] OpenAI. 2023. Whisper. OpenAI.

[32] OSF. 2022. Workshop Design Cards. https://openseriousgames.org/osg-606-workshop-design-cards/.

[33] Dorian Peters, Lian Loke, and Naseem Ahmadpour. 2021. Toolkits, cards and games–a review of analogue tools for collaborative ideation. *CoDesign* 17, 4 (2021), 410–434.

[34] Thibault Raffaillac, Nadia Boukhelifa, Emilie Crouzat, Fabien Stark, Jean-Pierre Müller, and Jacques Lasseur. 2023. Développement d'une Interface de Simulation Multi-Agents Pour La Gestion Concertée Des Territoires Pastoraux de Moyenne Montagne. In *Adjunct Proceedings of the 34th Conference on l'Interaction Humain-Machine (IHM '23 Adjunct).* Association for Computing Machinery, New York, NY, USA, 1–6. https://doi.org/10.1145/3577590.3589606

[35] Robin Roy and James Warren. 2018. Card-Based Tools for Creative and Systematic Design. In *Design Research Society Conference 2018.* Design Research Society, UK, 1075–1087. https://doi.org/10.21606/drs.2018.284

[36] Puripant Ruchikachorn and Klaus Mueller. 2015. Learning visualizations by analogy: Promoting visual literacy through visualization morphing. *IEEE transactions on visualization and computer graphics* 21, 9 (2015), 1028–1044.

[37] Julie Ryschawy, Justine Faure, Fernanda G. Moojen, and Vincent Thenard. 2021. Serious Game: A Cutting-Edge Tool for Stakeholders to Redesign Livestock Systems towards Agroecology. In *72. Annual Meeting of the European Federation of Animal Science (EAAP)*, Vol. 27. Wageningen Academic Publishers, Wageningen, 464.

[38] Eliane Schreuder, Jan van Erp, Alexander Toet, and Victor L. Kallen. 2016. Emotional Responses to Multisensory Environmental Stimuli: A Conceptual Framework and Literature Review. *SAGE Open* 6, 1 (Jan. 2016), 2158244016630591. https://doi.org/10.1177/2158244016630591

[39] Olaf Schroth, Ulrike Wissen Hayek, Eckart Lange, Stephen RJ Sheppard, and Willy A Schmid. 2011. Multiple-case study of landscape visualizations as a tool in transdisciplinary planning workshops. *Landscape Journal* 30, 1 (2011), 53–71.

[40] B. Shneiderman. 1996. The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations. In *Proceedings 1996 IEEE Symposium on Visual Languages.* IEEE, Piscataway, NJ, 336–343. https://doi.org/10.1109/VL.1996.545307

[41] Frank Siedlok and Paul Hibbert. 2014. The Organization of Interdisciplinary Research: Modes, Drivers and Barriers. *International Journal of Management Reviews* 16, 2 (2014), 194–210. https://doi.org/10.1111/ijmr.12016

[42] Roderick I. Swaab, Tom Postmes, Peter Neijens, Marius H. Kiers, and Adrie C.M. Dumay. 2002. Multiparty Negotiation Support: The Role of Visualization's Influence on the Development of Shared Mental Models. *Journal of Management Information Systems* 19, 1 (July 2002), 129–150. https://doi.org/10.1080/07421222.2002.11045708

[43] Silvia Tobias, Tobias Buser, and Matthias Buchecker. 2016. Does Real-Time Visualization Support Local Stakeholders in Developing Landscape Visions? *Environment and Planning B: Planning and Design* 43, 1 (Jan. 2016), 184–197. https://doi.org/10.1177/0265813515603866

[44] Paul Tol. 2021. Qualitative Color Schemes. https://personal.sron.nl/~pault/.

[45] Bärbel Tress and Gunther Tress. 2003. Scenario Visualisation for Participatory Landscape Planning—a Study from Denmark. *Landscape and Urban Planning* 64, 3 (July 2003), 161–178. https://doi.org/10.1016/S0169-2046(02)00219-0

[46] Alexey Voinov, Karen Jenni, Steven Gray, Nagesh Kolagani, Pierre D. Glynn, Pierre Bommel, Christina Prell, Moira Zellner, Michael Paolisso, Rebecca Jordan, Eleanor Sterling, Laura Schmitt Olabisi, Philippe J. Giabbanelli, Zhanli Sun, Christophe Le Page, Sondoss Elsawah, Todd K. BenDor, Klaus Hubacek, Bethany K. Laursen, Antonie Jetter, Laura Basco-Carrera, Alison Singer, Laura Young, Jessica Brunacini, and Alex Smajgl. 2018. Tools and Methods in Participatory Modeling: Selecting the Right Tool for the Job. *Environmental Modelling & Software* 109 (Nov. 2018), 232–255. https://doi.org/10.1016/j.envsoft.2018.08.028

[47] Christiane Wölfel and Timothy Merritt. 2013. Method Card Design Dimensions: A Survey of Card-Based Design Tools. In *Human-Computer Interaction – INTERACT 2013 (Lecture Notes in Computer Science)*, Paula Kotzé, Gary Marsden, Gitte Lindgaard, Janet Wesson, and Marco Winckler (Eds.). Springer, Berlin, Heidelberg, 479–486. https://doi.org/10.1007/978-3-642-40483-2_34