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Simulating ‘step zero’. Empirical lessons for engaging stakeholder dialogue on collective management of organic waste

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ABSTRACT

Shifting sociotechnical systems towards sustainability requires getting local stakeholders to cooperate and design the most relevant technical and social changes. Collective management initiatives based on stakeholder dialogue are widely studied in literature, mostly supported by *ex post* lessons obtained from successful case studies, with little consideration for the initiation stage. To fill this important gap, this study analyzes stakeholders’ interests for dialogue before the action starts. To this end, we use the concept of plausible promise: the discourse formulated by the initiating actor to engage collective action. We have developed an original methodology to conceive and assess plausible promises in a situation where collective management is of great potential interest, but not yet being implemented. The case study concerns the *Plaine de Versailles*, where recycling organic waste could be significantly improved by collective management, i.e. used in agriculture as a substitute for other re-sources according to the industrial symbiosis principles. We carried out simulations with 19 key local stake-holders who were asked to evaluate their interest in possible collective management initiatives represented by nine plausible promises. Our results indicate that non-specific plausible promises may be sufficient to get stakeholders involved. The performativity of more specific promises depended on their time perspective; for instance, providing many details on collective management in a long-term perspective proved to be counter-productive. We conclude that convincing the relevant actors to join a dialogue may not require an important level of knowledge on unsustainable situations. However, such knowledge remains a prerequisite for the initiating actor to design his/her project.

Keywords:

Plausible promise
Collective innovation
Initiation
Bioeconomy
Circular economy

1. Introduction

1.1. Objectives of the study

Environmental transition requires the rapid development of multiple regional collective management processes so that key stakeholders can collaborate and agree upon the changes most likely to make their specific situations more sustainable (Berkes, 2017). In this context, there are many field based examples of collective management in literature (Gulliver et al., 2022), sometimes referred to as collective – or participatory – innovation (Berthet and Hickey, 2018). Many of these initiatives aim to improve the sustainable use of natural resources, for instance in agriculture (Pelzer et al., 2020), forestry (Jones et al., 2015)

or fisheries (Alexander et al., 2015). Industrial symbioses are examples of collective management initiatives that seek to increase the circularity of waste management systems (Simboli et al., 2014; Van Berkel et al., 2009). Initiating and enhancing such initiatives at regional scale are therefore key objectives in addressing the global sustainability challenge (Olsson et al., 2004). In their early stages, this type of collective action require the implementation of stakeholder dialogue (Queste and Wassenaar, 2019). Despite a large number of successful case studies (Neves et al., 2020), there is an important lack of understanding on why stakeholders would accept or refuse to participate in this dialogue in the first place. The present study aims to bring new perspectives on the initiation of stakeholder dialogue with a novel approach, involving an original *ex ante* standpoint on an existing situation. We call on the

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concept of plausible promise (Douthwaite et al., 2001), which has been shown to be a valuable framework for analyzing collective action in the context of industrial symbioses (Bijon et al., 2022). This framework has, however, not yet been tested for initiating stakeholder dialogue on collective management, which involves major methodological challenges that we address here. We chose to experiment plausible promises for dialogue initiation at the *Plaine de Versailles*, a French agri-urban landscape with a high potential for improving the recycling of organic waste in agriculture, particularly through collective management. Our research question is the following: “How do the characteristics of plausible promises influence the success of stakeholder dialogue initiation?”. To answer this, the study pursues three specific objectives: (1) to develop an original methodology to study the initiation of stakeholder dialogue based on the concept of plausible promise; (2) to apply this method to the *Plaine de Versailles* and analyze the results by testing theoretical hypotheses; and (3) from this example, to derive general principles and recommendations for the design of plausible promises.

1.2. The ‘step-zero’ gap: how does collective management start?

The initiation of stakeholder dialogue is not always a central question in collective management. Indeed, in some situations, initiatives start spontaneously driven by salient, urgent or conflictual regional issues, as for instance the competition for grazing land (Alemayehu et al., 2013), conflicts in coastal management (Stepanova, 2015), or pressure on water resource (Branson, 2016). In this case, the nature of the problem is clear, and the collective action is dedicated to reaching mutual understanding and the cooperation of all the actors involved (Johansen and Upham, 2019). However, in a large number of situations, though there is a high potential for increasing sustainability through collective action, the exact nature of the problem remains controversial (Ison, 2016) and the key stakeholders’ knowledge of the environmental issues may be limited (Mancheva, 2018). This is the case of organic waste management, which involves complex biophysical phenomena, while also being a priority on institutional and political agendas including those of the bioeconomy (Bugge et al., 2016; European Commission, 2018) or the circular economy (McDowall et al., 2017). In such situations, initiating stakeholder dialogue is far from spontaneous, and can be considered as an integral part of collective innovation requiring active enrolment actions (Gopnik et al., 2012). In the case of environmental crises, the scientific community may be a legitimate actor to initiate collective actions, as advocated by post-normal science (Funtowicz and Ravetz, 1993) and participatory action research (Chevalier and Buckles, 2019). So far, very few studies have been dedicated to this ‘step-zero’ (Chuenpagdee and Jentoft, 2007). Most studies that attempt to draw lessons on this topic are based on case studies where collective management is already implemented (Spekkink and Boons, 2016; White and Runge, 1995). Such *ex post* assessments cannot inform on the optimal initiation process, since such modalities may well not yet have been put into practice. Mancheva (2018) carried out one of the few *ex ante* assessments, highlighting the importance of stakeholder knowledge and conviction. However, the required level of formalization of this knowledge remains unexplored and the lack of dedicated research may indeed preclude potential stakeholder dialogue. The theoretical framework of the plausible promise offers the possibility to address this question through a rigorous experimental protocol.

1.3. Plausible promises: a tool to study the initiation of collective action

Developed in the context of integrated natural resource management (Douthwaite et al., 2009), the plausible promise conceptual tool is an element of inclusive innovation (Hoffecker, 2021), i.e. an innovation process that includes the actors targeted by innovation. According to Douthwaite et al. (2001), a plausible promise corresponds to a technical proposal for an innovation that is incomplete but nevertheless sufficiently credible to engage actors in its participatory design. In a previous

publication, we defined plausible promises as “the discourse of an initiating actor (or group of actors) confronted with a specific situation, formulated in a way designed to enroll a group of target actors in a collective process to address this situation” (Bijon et al., 2022, p.3). The ability of this discourse to actually trigger actions, namely to involve the targeted actors in a dialogue, is called its *performativity* (Joly, 2010). Plausible promises are a relevant tool for studying collective actions, especially how they start. In the given definition, the “situation” corresponds to the statement of a problem or an opportunity by the initiating actor – in this case, a member of the scientific community – to justify the actions to be taken – here, a collective management process. Two major dimensions of such a situation are its time perspective and level of specificity (Bijon et al., 2022). However, plausible promises have never benefited from dedicated research to identify their optimal formulation. This allows reformulating the research question as follows: How do the time perspective and the level of specificity of a plausible promise influence its performativity in initiating a stakeholder dialogue?

1.4. The implicit theory of an optimal plausible promise

Many tools and frameworks for stakeholder dialogue are available in the literature (Emerson et al., 2012; Halbe et al., 2018; Ostrom, 2015), but none reports how such dialogues are initiated. Some methods give generic advice, for instance, Beuret indicates that an agreement on the object to be discussed, an “acceptable common object”, is a prerequisite (Beuret, 2013). He states that “regarding the object, the participants, and the scale of the dialogue, only the parts of the ‘greatest common denominator’ will be retained” (Beuret, 2006, p.116). Studies on industrial symbioses suggest that the greater the uncertainties at the beginning – the less obvious the common object – the more open the initial objectives should be (Abitbol, 2012). Douthwaite & Gummert state: “The plausible promise does not need to be refined or polished; it can be imperfect and incomplete. In fact, the less final it is, the more scope there is for the stakeholders to innovate and thus gain ownership of the technology. The more problems there are, then the greater the chances that the key stakeholders will give up in frustration” (Douthwaite and Gummert, 2010, p.248). Beuret similarly suggests that initial ambitions should remain sufficiently modest to allow the possibility for dialogue, while not being too low to arouse interest in a dialogue. This expresses the implicit hypothesis of an optimal plausible promise, between a discourse that is too simplistic to interest the actors – due to too many ill-defined problems (Ison, 2008) – and a discourse that is too advanced to allow the actors to contribute enough to defining the objectives of collective management. However, to our knowledge, no studies have provided empirical evidence of such a phenomenon to date. Our work aims at addressing this gap on the basis of three research hypotheses.

1.5. Research hypotheses

To assess the implicit assumption of an ‘optimal level of complexity’ followed in the literature, we formulate the following hypotheses:

(H1) The content of plausible promises does influence the interest of the stakeholders in participating in the regional symbiosis. Otherwise, it would be possible that the stakeholders’ interest is mainly driven by external components of the sociotechnical system independent of the formulation of the plausible promise. This requires that the assessment of plausible promises by the stakeholders can be qualitatively linked to their content and the way they have been designed.

(H2) This interest stems, at least partly, from agreement with a scientific analysis of the situation of the territory. Indeed, assuming that hypothesis (H1) is confirmed, it is possible that the interest does not derive from the technical and scientific elements upon which the plausible promises have been built. First, this implies that the conception of plausible promises is firmly grounded in scientific facts or on modeling based on these facts. Second, it implies that in addition to the

performativity of PPs, their realism for the stakeholders also needs to be assessed.

(H3) Psychological factors and individual specificities can be disregarded in understanding the performativity of plausible promises. Such factors are known to have an important influence on actors' reactions, as shown by behavior economy (Tversky and Kahneman, 1974). However, analysis of a complex system of interactions must look beyond individual decision factors (Russell and Lux, 2009). Moreover, investigating such factors requires quantitative approaches that are not suitable for the qualitative approach required by our (H1). Consequently, we focused on the strategic analysis of actors and stakeholders (dos Muchangos et al., 2017; Mermet et al., 2005), and our interviewees were asked to answer as representatives of their professional organizations.

1.6. Simulation of an industrial symbiosis in a bioeconomic context

To study the research question and the three research hypotheses, we focused on an actual situation where stakeholder dialogue could be – but has not yet been – implemented. Regional management of organic waste (OW) is a suitable topic to investigate this question as it involves a wide range of actors including municipalities, enterprises, farmers, or NGOs, who usually conduct their activities independently from one another (Vanhamäki et al., 2020). As a result, recycling of OW remains below its potential (Trimmer and Guest, 2018), and nutrients contained in waste hardly substitute for non-renewable mineral fertilizers in agriculture (Billen et al., 2014). Such a 'metabolic rift' (Bahers and Giacchè, 2019) can be found in relatively small geographical areas, such as a "growing megacity with intensive suburban livestock production, constituting the sink for nutrient originating from an agricultural hinterland with impoverishing soils (...)" (Wassenaar et al., 2016, p.99). In such a case, proper management of these wastes is indispensable to progress toward a sustainable bioeconomy (Sherwood, 2020), guarantee food security, and limit the environmental impact of today's waste management systems (Sutton et al., 2013). In France, the *Plaine de Versailles* is a region with such potential (Moinard et al., 2021), but where no collective management has yet been implemented. This case study is thus a suitable context to simulate the initiation of stakeholder dialogue for collective management of OW, including the design of plausible promises and their assessment by the actors of the *Plaine de Versailles* territory.

2. Material and methods

2.1. Methodology overview and research strategy

We experimentally studied our research question in a situation where collective management was deemed appropriate by experts but had not yet been implemented. According to Yin (2018), a case study approach is "an empirical method that investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident." Yin considers this approach to be especially relevant for understanding a contemporary situation, where experimental control of the events is not possible, which is the case in the initiation of stakeholder dialogue. However, our goal excludes studying existing case studies of collective management, since these initiatives involved only *one* initial plausible promise that would not provide information about *other* plausible promises that could have enabled their initiation. Moreover, as no *ex-ante* study of the initiation of a stakeholder dialogue using plausible promises has been undertaken, no methodological framework or guidelines are available. The general principle chosen for this study was to simulate, in one single-case study, the initiation of dialogue with stakeholders among whom collective management would be relevant. The simulation approach consisted in presenting hypothetical collective management projects embedded in plausible promises and recording the respondents' reactions (Etienne,

2010).

Fig. 1 presents the methodological steps followed. Once the case study was selected, the first step consisted in assessing the selected territory based on literature, interviews, and observations in order to identify technical principles for the conception of relevant plausible promises and to identify actors who would be relevant stakeholders in the corresponding collective management. Based on this knowledge, the second step was to conceive plausible promises that could be used in simulations. The third step consisted in performing the simulations during interviews that allowed assessment of the plausible promises by the actors, and justifications for their assessment. In a final fourth step, the analysis of the reaction of respondents, recorded in multiple ways and presenting both qualitative and quantitative aspects, then allowed answering the research question.

2.2. The case study of the Plaine de Versailles: a potential for synergies

The *Plaine de Versailles* (Fig. 2) is an agri-urban area located close to the cities of Versailles (250 000 inhabitants) and Paris (2M inhabitants) and is characterized by around 10 000 ha of intensive cereal cropping. This area was chosen for its potential to be both a revelatory and critical case study (Yin, 2018). First, many studies have been conducted in the *Plaine de Versailles* area (Dhaouadi, 2014; Joncoux, 2014; Moinard et al., 2021; Noiro-Cosson, 2016), which provide important and valuable information on its Organic Waste Management System (OWMS). The availability of this local knowledge creates an opportunity to design relevant plausible promises. Second, these studies identified a substantial potential for OW recycling in the area (Moinard et al., 2021). Theoretically, the amount of nutrients contained in the region's OW could satisfy crop requirements. Despite the existence of recycling practices in this area – such as the composting of green waste and the spreading of the compost – 96% of the nitrogen used in agriculture comes from nonrenewable, mineral inputs. Indeed, nitrogen used for intensive agriculture is almost all mineral, whereas most of the recycled nutrients are in the form of organic complexes that are not instantly accessible for plant growth. In addition, no single individual type of OW has the right nutrient composition that matches the balance required by crops. Therefore, OW currently available to farmers does not meet their requirements. In this situation, regional symbiosis could foster nutrient recycling through an OWMS that provides suitable resources to local farmers (Dhaouadi, 2014). This situation is of great interest for implementing stakeholder dialogue and corresponds to an issue known to require a plausible promise (Wassenaar et al., 2014), making it an outstanding example for studying this theoretical framework. The boundaries of the case study correspond to the actors involved in the OWMS of the representative geographical area in which a patrimonial association (French acronym APPVPA) federates farmers and a large number of municipalities, promoting sustained and sustainable agriculture (Fig. 2). This perimeter provided a geographical focus, but our study was not limited to it, as some stakeholders are located beyond its boundaries.

2.3. Conception of plausible promises

We conceived three contrasting *situations* corresponding to three technical scenarios representing three distinct temporal perspectives, listed in Table 1. The design and assessment of these technical scenarios were performed in collaboration with experts from Veolia Research and Innovation, an industrial partner associated with this research project, who has extensive multidisciplinary technical knowledge of organic waste management (Bijon, 2022).

Each scenario corresponds to one plausible promise session (S1, S2, S3), each one explained with three different levels of detail (D1, D2, D3) as shown in Table 2. Hereafter, a plausible promise is identified by its session number (Si) and its level of detail (Dj), e.g. S1-D2 is the plausible promise described in the second level of detail in the short-term

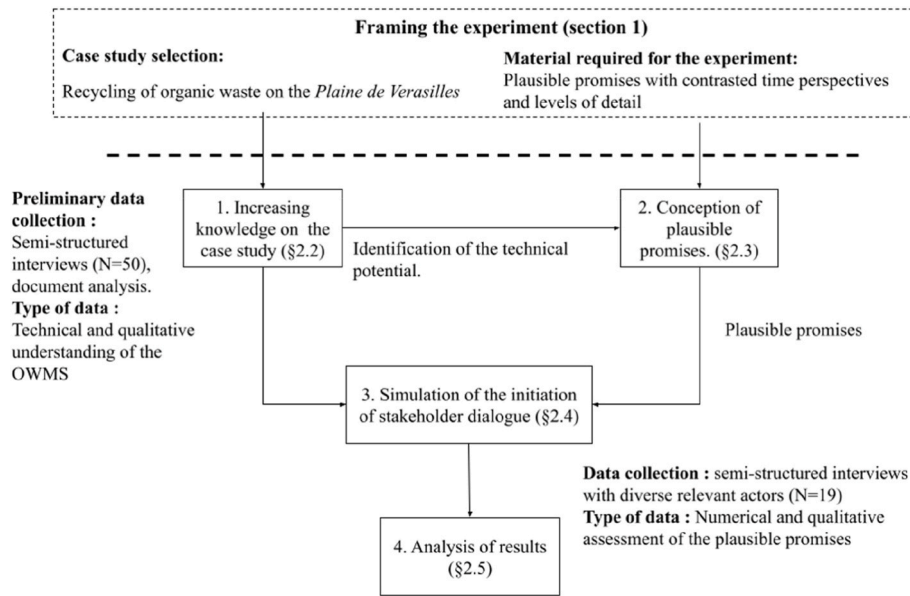


Fig. 1. Generic research strategy to study the initiation of collective management with the conceptual tool of plausible promises.

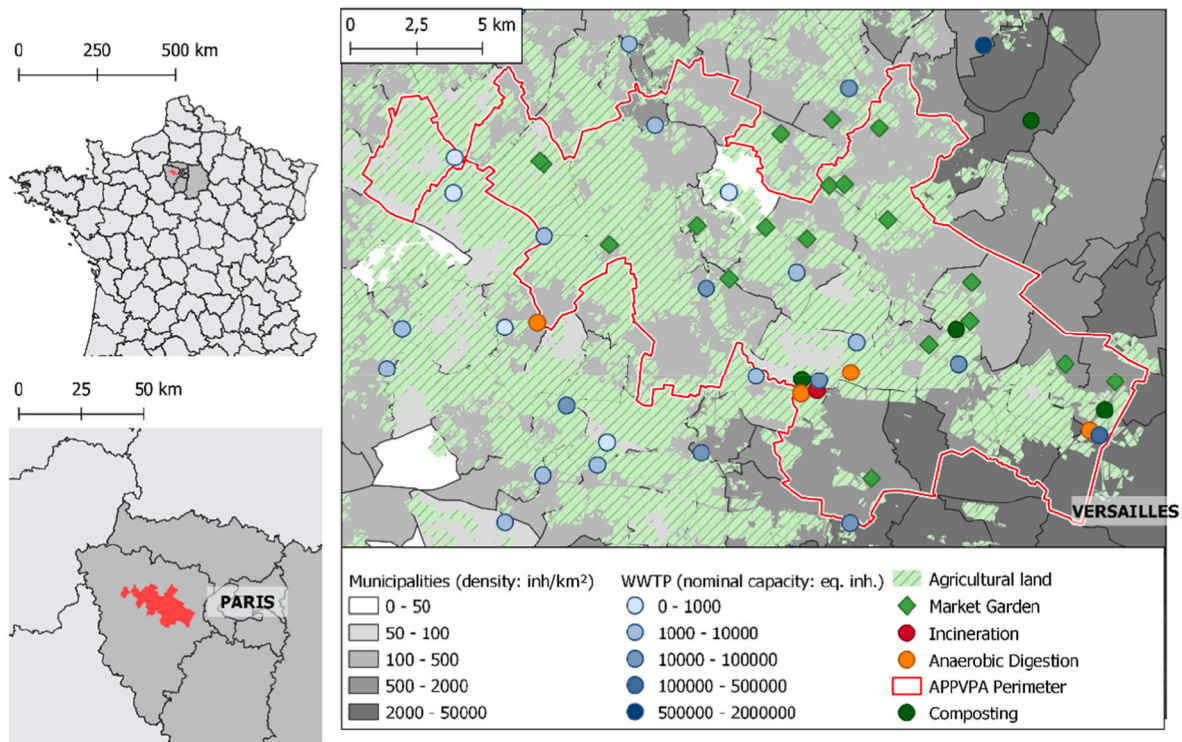


Fig. 2. Region of the Plaine de Versailles and main features linked to the potential recycling of organic waste in agriculture. WWTP: wastewater treatment plants. Data: INSEE, RGP, Sinoe, Sandre, Boros et al. (2022).

scenario. This resulted in a sequence of nine distinct plausible promises recorded as short audio messages (1–3 min each) to be sure each actor would hear the same message during the interviews. For the full text of plausible promises presented, see [Appendix A.1](#).

2.4. Data collection: interview design for carrying simulations

2.4.1. Selection of interviewees

The selection of interviewees to assess the plausible promises took place in three steps: (1) a preliminary interview phase, (2) the selection

of a diversified but balanced panel of actors, and (3) the identification of people who were qualified to represent the selected organizations. The interviewees considered as suitable to assess the plausible promises were first identified through preliminary interviews with a large diverse sample of actors of the OWMS: NGOs (10), businesses (19), local authorities and public institutions (21), state administrations (5) and other actors (3). These interviews were conducted using snowball sampling (David, 2008), a good method to map complex sociotechnical systems (Ghinoi et al., 2020). After this step, we designed a sample of relevant actors to assess the plausible promises. Based on the categorization of

Table 1

Synthesis of the three scenarios integrated into the three sessions of audio excerpts used during the interviews.

| Session (scenario) | Time perspective | Description of the scenario |
|--------------------|------------------|---|
| S1 | Short term | The focus is on the currently untapped potential (see 2.2); collective management is presented as a paradigm of change. |
| S2 | Medium term | A scenario consistent with current French regulatory perspectives and industrial development, targeting waste flows that are already easily accessible and enhancement of their availability and quality for farmers, resulting in increased composting and anaerobic digestion treatments. |
| S3 | Long term | Ambitious sociotechnical transition scenarios, including a major change in the sanitation system currently the main source of nutrient loss. The new system will involve separating urine (Martin et al., 2020), microalgae sanitation (Polprasert and Kootatep, 2017), and nutrient extraction (Mehta et al., 2015). |

Table 2

Synthesis of the three levels of detail used in the plausible promises.

| Detail level | Description | Details included |
|--------------|--------------------------|---|
| D1 | Vague | Ill-defined objectives, few specifications, no technological perspectives |
| D2 | Technically detailed | Defined objectives, accurate description of technical potential, statement of technological perspectives |
| D3 | Comprehensively detailed | Regulatory, economic, and environmental specifications. Presentation of a supposedly available, dynamic modeling tool and of the graphical results obtainable with this tool. |

different roles within the OWMS (Bijon, 2022), we selected actors for each role to be sure all the categories were represented by a comparable number of diverse actors. This requirement intrinsically limits the number of possible interviews, since some categories involve very few actors. For instance, few waste treatment platforms, or political actors exist compared to the number of farmers or waste producers. The person interviewed in each selected organization had to have the power of decision, or at least had to be able to answer as if he/she had such power. During the interviews, the interviewees were asked to give their organization's opinion rather than their personal judgement, in accordance with hypothesis (H3). The availability of such an interlocutor was the last, uncontrolled selection criterion. This selection process resulted in the 19 stakeholders listed in Table 3.

2.4.2. Structure of the interviews

The interviews included three sections and lasted approximately 90 min in total. The first section consisted of semi-structured questions (Romelaer, 2005) aimed at collecting general information about the interviewee and the factors that influenced his/her activity. The second section corresponded to the interviewee's assessment of the plausible promises, during which the respondents were asked to listen to the nine plausible promises, score them with grades, and comment on their grades. The third section consisted in a final and less formal semi-structured exchange in which the interviewee could comment on his/her answers. The complete interview guide is provided in Appendix A.4.

2.5. Analysis methodology

The analysis aimed to (1) assess the scores obtained by each plausible promise, (2) identify performativity and credibility factors among the

Table 3

Actors selected to assess plausible promises. Most of the actors play several roles in the OWMS. This table indicates which role was considered to be their main role in selecting the representative panel of interviewees.

| Role in the OWMS | Description of interviewee |
|--|---|
| Role in the physical interaction system | |
| Organic waste production | Quality manager in a catering enterprise Manager of equestrian center |
| Organic waste treatment | Engineer specialized in OW in a local waste management company with multiple operations including composting of green waste, micro-anaerobic digestion, and a sorting platform. Director of a green waste composting plant Director of a wastewater treatment plant Director of an anaerobic digestion plant |
| Organic waste collection | Director of an OW collection company conducting hygienization outside the territory |
| Organic waste use | Transporter of horse manure Market gardener Market gardener and cereal farmer Conventional cereal farmer Organic and conventional cereal farmer |
| Role in the influence system | |
| Facilitation (diffusion of information, organization of meetings, etc.) | President of a citizen's NGO that promotes sustainable development |
| Federating (spokesman for the interest of groups of actors) | Advisor to a Consular Chamber of Agriculture Facilitator of APPVPA |
| Solution promotion (solicitation of local stakeholders to promote technical or non-technical services) | Director of a company that advises organic waste producers on implementing decentralized treatment solutions Chief advisor of a company that advises organic waste producers, namely by promoting electromechanical composting units |
| Regulation (establishing and enforcing rules) | Elected representative of a local urban municipality Technical manager of a regional waste management authority responsible for waste collection |

plausible promises and their importance in the actors' justification of the scores they awarded, and (3) clarify the link between the performativity and realism of the plausible promises. To achieve these objectives, we conducted a numerical analysis of the scores, complemented with a qualitative analysis. The small number of respondents (19) excluded a statistically robust quantitative analysis of the plausible promises. Therefore, the validation of our analysis does not stem from the numerical analysis but is instead achieved through the combination of the numerical observations with qualitative analyses.

2.5.1. Analysis of the scores

Each interview provided nine pairs of interest/realism scores. We also calculated relative scores to represent the change in score between a plausible promise with a detail level D_i and a plausible promise with the detail level D_{i+1} . This resulted in two relative scores for interest and realism per session, or six changes in the interest/realism score per interview. The scores and changes in scores were compared using descriptive statistical indicators such as means, variation coefficient, and standard deviation. The scores were grouped into classes to represent their distribution. The sessions were compared using three methods: the mean scores of the three plausible promises of the session, the session scores, and the session ranking. We used the normalized covariance (Andraszewicz and Rieskamp, 2014) of interest and realism across all observations as well as the correlation coefficient to analyze the relation between interest and realism.

2.5.2. Qualitative analysis

The respondents accepted that the interviews be recorded. The

transcripts of the recordings were analyzed using the NVivo© software (Leech and Onwuegbuzie, 2011), enabling in-depth inductive and deductive qualitative analysis (Mackensen and Wille, 1999). We used the methodological principles of thematic coding (Peters and Wester, 2007). This consists in associating parts of the transcripts with relevant themes for the analysis and organizing the themes to build a consistent understanding of the interviews. The quality and robustness of coding can be estimated using the principle of saturation: i.e., after a certain number of interviews, the introduction of new codes does not disrupt the established code architecture (Morse, 2015). We analyzed the results in two steps. First, we performed inductive categorization of the objects of interest and realism, i.e., the objects on which respondents focused their attention and around which they developed their arguments. Second, we assessed the number of references to the elements as an indication of their weight, and the number of interviews that included them as an indication of frequency. Overall, this approach represents a compromise between inductive and deductive principles (Morse and Mitcham, 2002).

3. Results

3.1. Analysis of the scores

3.1.1. Description of the scores

Fig. 3 presents the mean and distribution of the scores obtained by the different plausible promises. Variation coefficients ranged from 0.25 to 0.45, and the distribution profiles were heterogeneous. The scores indicate a globally positive reaction towards collective management (Fig. 3-A). Most of the grades were good (>6) or excellent (>8), and most of the means for interest were greater than 7, and for realism, greater than 6. Despite the similarity in the scores and high standard deviation, their contrasted distribution suggests that the three sessions led to a different logic of reaction by the actors (Fig. 3-B), which was confirmed by the analysis of relative scores (Fig. 3-C and -D). In Session 1, increasing the level of detail slightly reduced the realism scores, whereas it did not seem to affect the interest scores. We observed a normal-shaped distribution of score variations with an increase in the level of detail (Fig. 3-D1 and D4). In Session 2, we observed opposite trends for interest and realism at the detail level D3: realism increased and interest decreased (Fig. 3-D2). Plausible promise S2-D2 obtained the highest score. Despite a very small numerical difference with S1-D3, S2-D2 appeared to be distinct from the other plausible promises, with a lower standard deviation, the most scores above 8, and the least scores below 4. The plausible promise that obtained the highest mean for realism in similar conditions was S2-D3. In Session 3, the increase in the level of detail caused a general reduction in interest and realism scores, meaning plausible promise S3-D2 and plausible promise S3-D3 had the lowest scores for both interest and realism. They also had higher standard deviations, revealing more polarized opinions.

3.1.2. Relation between interest and realism

The correlation coefficient of scores between interest and realism was 0.22, with a normalized covariance of 0.078 (Fig. 3-E1). The correlation between the variation in interest and the variation in realism when the level of detail was increased in a given session was 0.044, with a normalized covariance of 0.064 (Fig. 3-E2). These low values suggest an absence of correlation between interest and realism in both absolute and relative terms. In relative scores, we observed a few pairs in which contrasting changes in interest and realism reflected extreme reactions, and were thus not representative of the majority of pairs. Removing the three most extreme pairs increased the correlation coefficient to 0.34 and the normalized covariance to 0.256, however, these values are too low to confirm a significant correlation between variations in realism and interest. This suggests that interest and realism – and their respective changes – are neither independent nor highly correlated. A high score for interest can be associated with a low score for realism for the

same plausible promise. The change in relative scores was qualitatively similar (an increase in realism was generally associated with an increase in interest), but the intensity of the change was not proportional. For example, a small increase in realism could be associated with either a big or a small increase in interest.

3.2. Qualitative analysis

The high variability of the numerical results prevented the identification of marked differences between plausible promises and required qualitative analysis to understand the reasons for the scores. Fig. 4 presents the key findings of this analysis.

3.2.1. Description of the objects of interest and realism

The objects of interest and the objects of realism corresponded to problems perceived by the respondents and taken into account in their assessment of a plausible promise, appearing as verbalized arguments. We identified 200 arguments justifying interest scores and 140 arguments justifying realism scores. We grouped the objects of both interest and realism in five object categories: (1) initial stakes, (2) stakeholder dialogue process, (3) reaction of other stakeholders, (4) perspectives of collective action, and (5) formal aspects of discourse (Fig. 4-A). The objects could either be referred to positively to justify high scores or an increase in score, or negatively to justify low scores or a reduction in score. The justifications not only mentioned technical aspects of the plausible promises, but also non-technical aspects such as environmental, regulatory, political, social, or political factors (Fig. 4-B).

The initial issues corresponded to the existing state in which, based on the stakeholder's knowledge, collective management is deemed necessary. The initial issues were taken into consideration when valuing the interest in 13/19 interviews and often represented positive levers for stakeholder engagement (80% of the arguments were positive). It includes both technical aspects – for instance, the reactions to the numbers provided in the plausible promise – and non-technical aspects – such as an unfavorable regulatory context due to constraining urbanization policies. In the following sentence, the actor is invested in regulations, which is a source of interest:

You mentioned standardization, homologation, end-of-waste status, well, that's exactly the topic.

OW treatment stakeholder, S2, December 2021

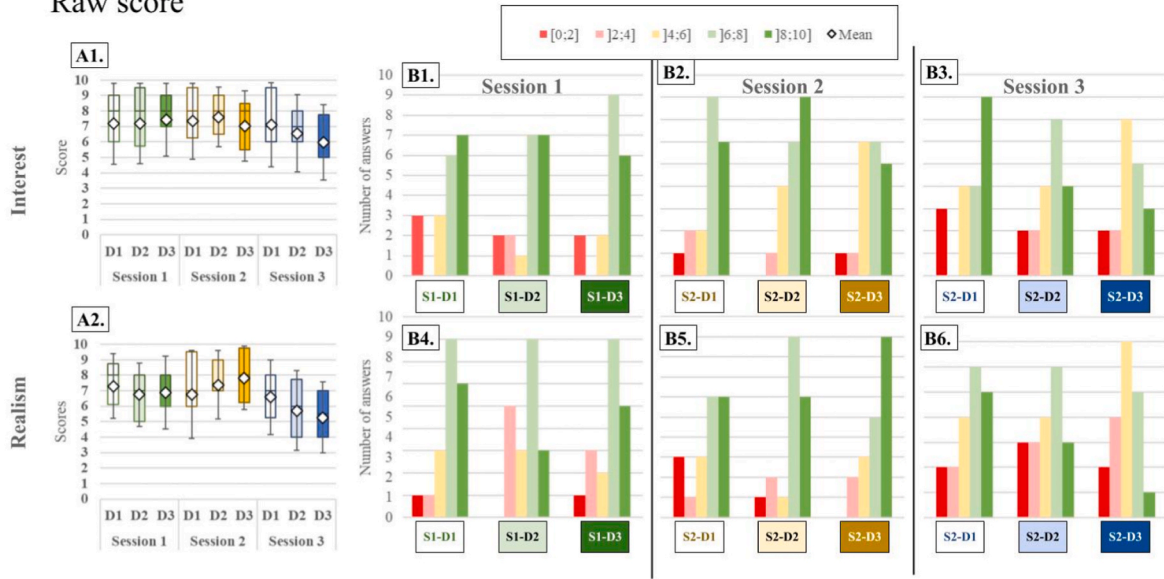
The principle of a stakeholder dialogue *per se* represented an element of interest in 16/19 interviews, despite the fact that little information was provided by the plausible promises. It corresponded to the anticipated perception of the quality of the dialogue process, often from a standpoint of caution (65% negative arguments). It mostly involved non-technical factors such as the time frame of the actions, the inclusion of appropriate stakeholders, or the neutrality of the facilitator, sometimes referring to similar past experiences of varying degrees of success. For instance, the following sentence reveals hesitation due to the uncertain outcome of the process:

Basically – and what I am saying is a bit binary – the question is: do we get involved in a collective dialogue to produce something useful and an action, or will we be wasting our time?

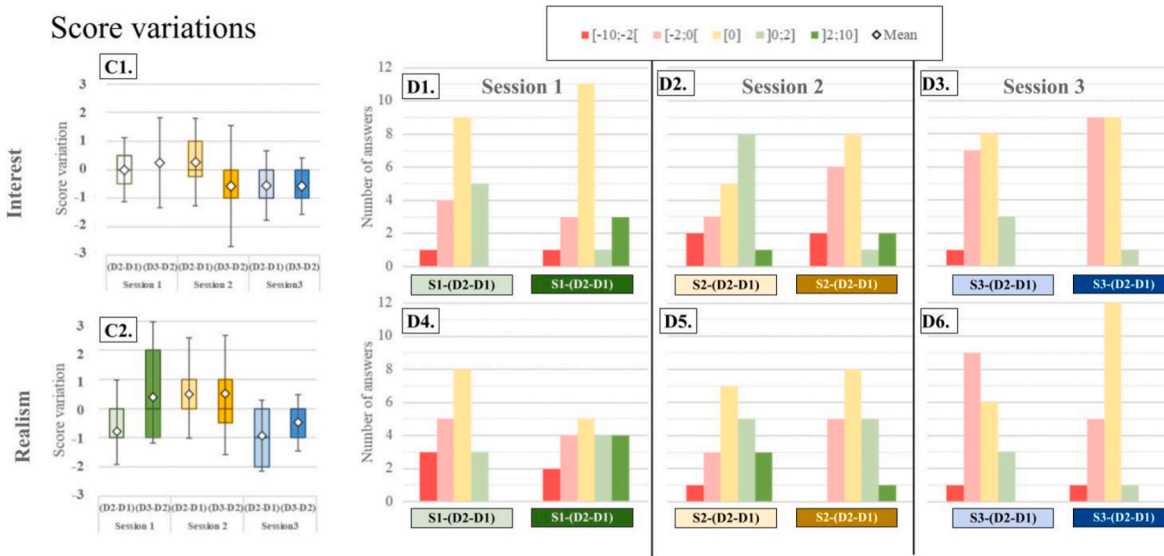
Facilitating stakeholder, interview conclusion, February 2022

Predicting the behavior of other stakeholders during the collective action was an object of interest in 13/19 interviews. It corresponds to trust – or lack thereof – in certain actors or groups of actors, perceived as a key to success. It also included acceptability of the technical solutions that could be proposed or promoted during the dialogue. If the collective action scenario is likely to conflict with the interests or practices of other stakeholders, it may reduce the realism of the plausible promise. For instance, the following sentence demonstrates uncertainty about the collective character of the dialogue:

Raw score



Score variations



Link between interest and realism

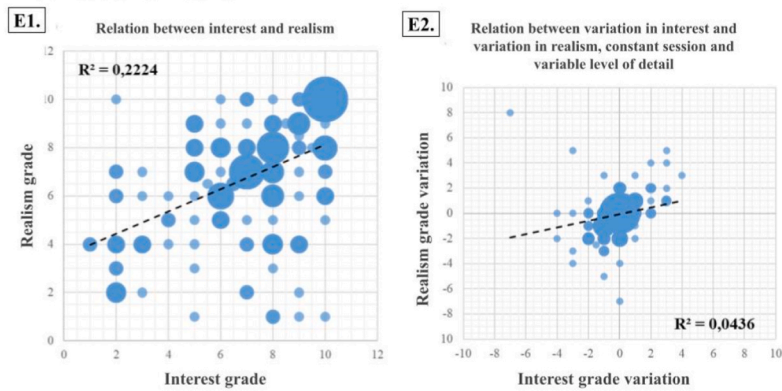


Fig. 3. Analysis of the grades given to the 9 plausible promises presented to the local stakeholder. See 2.3 for the description of the plausible promises, and 2.5.1 for the analysis details.

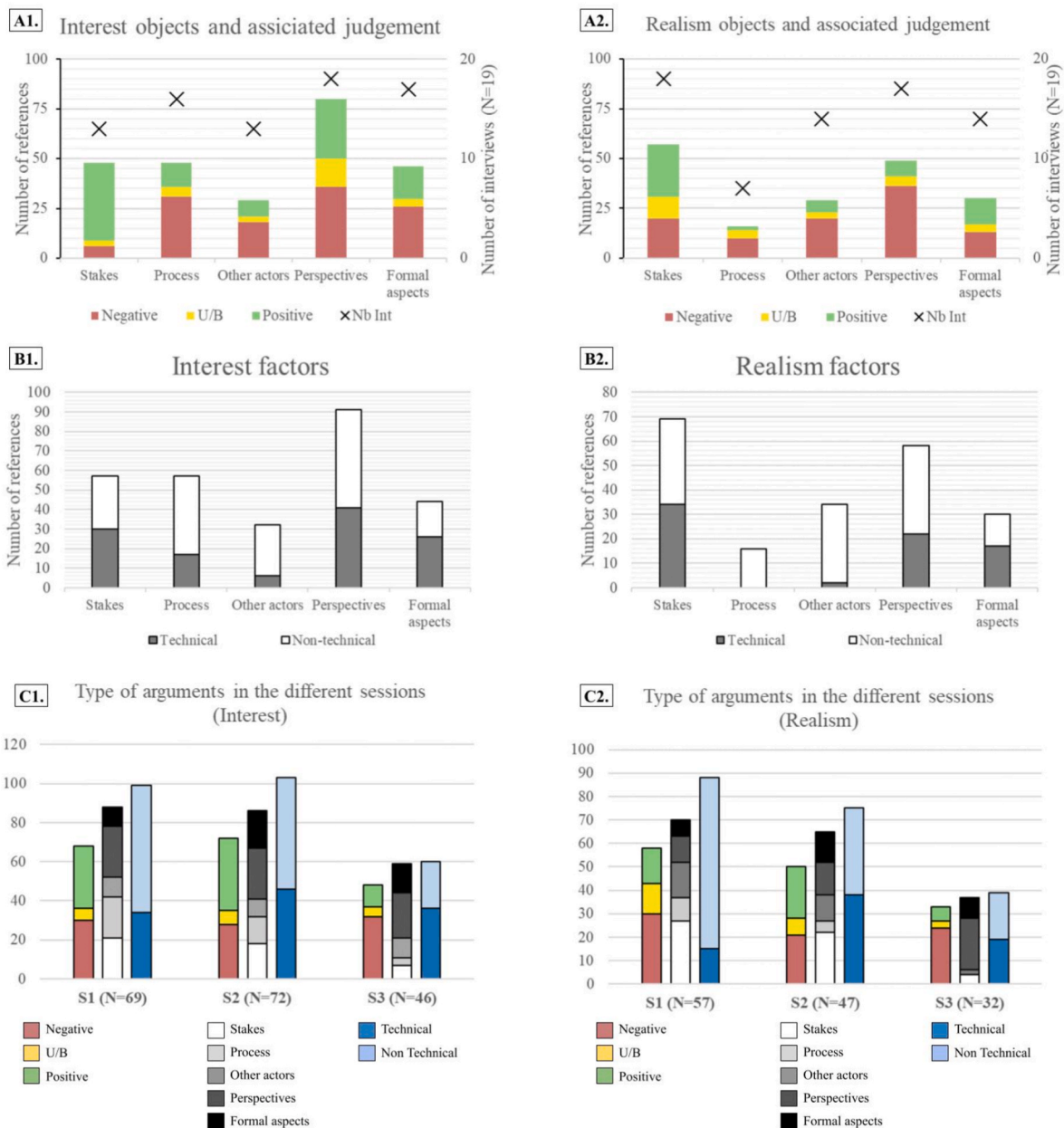


Fig. 4. Characterization of the identified arguments and sessions according to the qualitative analysis. U/B: Undetermined or Balanced. N = number of different arguments identified per session (note: arguments can concern multiple objects or integrate multiple factors, hence bars are not all equal in one session).

What is more, I am personally interested, but will all the actors be?
 OW collection stakeholder, S1, January 2022

The collective management perspectives are an important element of interest, present in 18/19 interviews. They can be considered as symmetrical to the issues, i.e. expectations of what it is appropriate to implement, given the initial state. Like the initial issues, they are inferred from knowledge and analysis of the situation, but predict the consequences of the collective management process. The respondents evaluated the relevance of the possible outcomes they perceive with respect to the initial issues and their own interest. Such outcomes covered both technical and non-technical aspects. This led to about the same number of positive and negative reactions. For instance, the following sentence shows that actors could be pessimistic about the outcomes due to regulatory constraints:

So really, everything is done to cause us trouble. (...) Maybe I do understand some political decisions, but I can imagine plenty of synergies that exclude us, and hardly any including us.

OW treatment stakeholder, S2, December 2021

The last category of objects is the formal aspects of the discourses. Wording, vocabulary, and tone were explicitly taken into account by the actors in their assessment in 17/19 interviews. For instance, supporting an argument with statistics can be a level of interest, while being vague and idealistic can raise suspicion. As an illustration, the following sentence reveals that a lessening of attention can penalize the results of plausible promises:

And, as I said, the way it's presented meant I wasn't really hooked until the end of the excerpt.

Solution promoting stakeholder, Session 3, November 2021

3.2.2. Qualitative analysis of the differences in reaction among the sessions

The qualitative analysis of justifications enabled a better understanding of the numerical results and the differences between the sessions (Fig. 4). In Session 1 and Session 2, the objects of interest and realism were more diversified than in S3 where the actors mainly focused on the perspectives and the formal aspects of the discourses (Fig. 4-C). Examining the proportion of positive and negative arguments allowed us to understand why the plausible promises in Session 3 received lower scores. In the two first sessions, the number of positive and negative answers was the same. This balance explains the high variability of the scores observed in the first two sessions. The equilibrium was slightly unfavorable in Session 1 and favorable in Session 2. In Session 3, the number of negative arguments was comparable to those in the two first sessions, but the number of positive arguments was too low to compensate. The same phenomenon applied to realism, where Session 1 had a more negative balance. These trends strongly supported the numerical results and suggest that the slight quantitative trends differ from random variations, despite low statistical significance.

In Session 1, since no future outlook was proposed in the plausible promises, the assessment of realism mainly focused on the initial issues. This realism not only referred to technical arguments but to multiple political, regulatory, social, or environmental factors. The actors were mostly aware of the constraining aspects of these factors, which affected their representations of dialogue and collective management and reduced the overall realism. However, despite this low non-technical realism, they were still very interested in the possibility of improving recycling. In this session, the actors mostly expressed a favorable opinion, but remain cautious and questioning as they considered the multidimensional uncertainty related to the collective action. As the following statement shows, the dialogue itself can be an interesting initiative for local stakeholders:

We are a company that needs income, so we are interested, because we are focused not only on selling machines, but also on obtaining knowledge of the market, of the stakes involved ... But strictly from the point of view of business and sales, it's a "waste of time"

Solution promoting stakeholder, S1, December 2021

The second session introduced technical perspectives which allowed the actors to predict outcomes. The fact that the perspectives were medium-term favored their realism and allowed Session 2 to obtain a slightly better score than Session 1. This was mainly evidenced by the D2 level of detail, which incorporated technological possibilities. At level D3, adding supplementary details was considered to be even more realistic and consistent with actual state. However, it led the dialogue onto a more specific pathway of collective management, favoring certain solutions – in this case, anaerobic digestion – over others. While this plausible promise maintained a high level of realism, the interest of actors was polarized by whether or not this orientation was in line with their own development strategy. This is the main explanation for the general decrease in interest observed from D2 to D3.

Here, we realize that we do not have the same target as people eligible for this meeting, so I would reduce my score, as I realize it is more for anaerobic digestion operators. And I come back to what I said before: we are the one financing anaerobic digestion, and they are the ones who will profit the most.

Regulating actor, S2, January 2022

In Session 3, the ambitious long-term outlook caught the attention of the respondents. The technical realism of an important shift in the OWMS, namely in the sanitation system, was considered to be unrealistic. Even if respondents were strategically interested in such developments, the high level and number of uncertainties concerning the future led to a significant reduction in interest. Other actors considered the focus to be far from their core business and activities, and consequently felt little concerned. We find a combination of these two barriers

in the following example:

Here it's totally abstract, it's utopia, it's too abstract for me as a practical person. (...) This is the ultimate step ... The urine story ... OK, but ... to me, it's a hypothesis, and before it is set up ... I don't even want to talk about it, it is not even my level, and doesn't concern me (...). It is only for researchers, but for the moment, I don't believe it.

OW user, S3, January 2022

4. Discussion

4.1. Interpretation of results

4.1.1. Lessons on plausible promises: why actors engage in dialogue

The five objects of interest and realism identified – i.e., initial stakes, dialogue process, other stakeholders, perspectives, and formal aspects, see 3.2.2. – are important factors that influence the motivation of stakeholders to participate in a dialogue. To summarize the results, we can infer that, based on our observations, stakeholders are willing to join a dialogue if at least one of the following conditions is fulfilled: (1) they are convinced that the stakes are important enough, (2) they value meeting other actors, be it in order to develop their activity or to increase the mutual knowledge of the territory, or (3) they are interested in the technical perspectives offered by the collective management. They will, on the contrary, mostly refuse to join when (1) they do not believe that the dialogue will result in actual local change, or (2) they think that they will not benefit from the envisaged technical perspective. We observed that the time frame of the collective project was important in shifting the actors' way of thinking. In the short-term plausible promises, they focused on diversified aspects, both technical and non-technical. In long-term plausible promises, they tended to focus more on technical aspects, especially if they considered them unrealistic. Consequently, increasing the level of detail produced different results depending on the time frame. Adding more detail helps to materialize the stakes in short-term plausible promises, or to materialize the future outlook in medium-term and long-term plausible promises. These details provide information on technical aspects that are far from being the only aspects that influence the interest of actors. Furthermore, even when acknowledged by the actors, a high degree of technical realism is not sufficient for enrolling stakeholders, particularly in long-term and prospective scenarios. As a result, we observed in our study a poor correlation between stakeholder interest and realism of the discourses.

4.1.2. Assessment of research hypotheses

These results shed light on the three hypotheses listed in section 1.5. Concerning (H1), our results confirm the hypothesis that the content of the discourses influences the assessment of stakeholders, as evidenced by the variations in the scores. Concerning (H2), the results are ambiguous. On the one hand, the justification indeed includes technical aspects and the knowledge provided concerning the existing situation. On the other hand, interest mostly proved to be independent of realism. This is likely due to the many non-technical factors involved in the actors' assessment. Concerning hypothesis (H3), despite leaving psychological factors aside in the experiment, the actors used a systematic and non-negligible number of arguments linked to the formal aspect of the plausible promises. Psychological and interpersonal bias, about which we have little information, probably played a role in the responses. Studying this aspect would require using a very different methodological approach that would not have been appropriate for the case studied here – mainly due to the small size of our sample.

4.1.3. Contrasts with literature

Our results illustrate the importance of focusing on the early stages of stakeholder dialogue that are generally overlooked. We show that the implicit hypothesis of an optimal plausible promise (Beuret, 2006;

Douthwaite and Gummert, 2010) is far from a general rule, even though it may be valid in some circumstances (e.g. as shown in the results for the second session of plausible promises, see Fig. 3-D2). However, one major finding of our study contradicting this hypothesis is that, in our case study, plausible promises with very little specific information can be sufficient to get stakeholders to engage in a dialogue for collective management. These results also contrast with those of Mancheva (2018) where the lack of actors' concern about technical aspects has been shown to be a major obstacle to their engagement. However, these previous results were obtained in a context involving more homogeneous actors – forest owners – in a less known and more specific challenge – collaboration for forest water management. In our case study, the high performativity of little specific discourses may be due to the fact that the stakeholders already share awareness of the environmental issues and of the urgent need to improve the situation, or simply because meeting other actors was a sufficient lever of interest. As a result, they were ready to join a stakeholder dialogue even if the exact form and direction it would take remained unclear. This result is in fact in line with previous indications of the high performativity of ill-defined concepts, named “ideographs” (Bijon et al., 2022; Bos et al., 2014).

4.2. Recommendations for the design of plausible promises

Our original approach brings important recommendations for those who promote collective management actions, including sustainability and post-normal scientists interested in participatory action research. In the situation investigated here, an advanced understanding of the synergy potential was neither a necessary nor a sufficient condition to convince the stakeholders to join in a dialogue. This suggests that complex technical representations such as advanced *ex-ante* modeling and assessments should not be considered a prerequisite for collective action. This also suggests that the initiation of dialogue may fail in an early stage when the non-technical aspects of the situation (regulatory, social, economic, environmental) are not sufficiently taken into account in the framing of the project. The main recommendation that we can derive from this study is that the efforts made by the initiating actor prior to the initiation of a stakeholder dialogue should be dedicated to understanding the sociotechnical system and identifying the most relevant projects and stakeholders on the territory, rather than modelling complex prospective scenarios. Despite the complexity of the situation, the plausible promise based on this knowledge may ultimately take much simpler form.

4.3. Future challenges

4.3.1. Extrapolation and limitations of the findings

As these results are based on the analysis of a single-case study, one can question to what extent they are specific to this situation, or can be extrapolated to other situations of collective management, such as waste recycling, industrial symbioses, or an even wider range of problems. Moreover, the design of the plausible promises used in this study involved assumptions about technical processes, social behavior, or technological progress (Barnaud et al., 2013). However, the considerations revealed by the qualitative analysis are not specific to the context of our study. In all collective management projects, regardless of the subject, one may expect stakeholders to be attentive to the initial issues, the quality of the dialogue process, the other actors, the evolution perspectives, and the formal aspect of the initiating discourses. Moreover, very detailed, long-term, and underdeveloped solutions can be expected to deviate from stakeholders' real business and reduce their interest, regardless of the exact shape they may take. We can also mention that the two dimensions assessed in this study, the time perspective and explicitness, can also be extrapolated to collective management in general. The observation that an explicit but brief discourse is enough to initiate stakeholder dialogue has no reason to be specific to our context (the *Plaine de Versailles*). Aside from other geographic locations, this

principle may also hold in contexts other than the collective management of organic waste. However, this does not imply it is universally valid. Non-technical factors proved to have an important influence on the actors' responses. These political, social, and cultural factors are the reflection of a strongly embedded sociotechnical system (Rip and Kemp, 1997). Other situations can be expected to differ depending on at least some of these contextual elements, which may influence the reaction to plausible promises. The main limitation of this case study is that it focused on only one type of sociocultural situation in a developed western country. It would be worthwhile to conduct similar studies in a situation where actors are less concerned about or constrained by environmental aspects. The methodology based on the theory of plausible promises developed in our work has an important potential of transferability to other situations.

4.3.2. Future research outlook

Despite providing precious information on the initiation stage, this study does not inform whether the collective management will subsequently reach its initial objectives. Collective management is assumed to have important benefits for sustainability at local scales (Berthet and Hickey, 2018). However, if ill-defined plausible promises are sufficient to initiate a stakeholder dialogue, what can really be expected regarding the quality of this dialogue? For example, will it be more prone to disagreement between stakeholders than a process based on more explicit plausible promises? Moreover, once a plausible promise has been formulated for local stakeholders, it inevitably creates an irreversibility in the system and will influence all posterior actions (Akrich et al., 2006). The importance of the link between the quality of dialogue initiation and the quality of the collective management has already been suggested (Chuenpagdee and Jentoft, 2007), but has not yet been assessed empirically. Addressing this question requires implementing ambitious research protocols for initiating multiple actual collective management stakeholder dialogues and assessing the influence of the initiation conditions on the subsequent process.

5. Conclusion

This paper offers two main contributions to foster collective management through stakeholder dialogue. First, it introduces a tool to explore *ex-ante* case study analysis which remains scarce in literature. We propose an original and transposable experimental approach to study the initiation of collective management stakeholder dialogues, based on the theory of plausible promises. This approach is particularly relevant for the analysis of situations where a dialogue has not yet been implemented. It also illustrates the importance of combining quantitative and qualitative analyses in such an exercise. Second, this methodology made it possible to understand a new aspect of dialogue initiation: the links between the design of plausible promises and their performativity. The results obtained in the case of organic waste management in the *Plaine de Versailles* region in France reveal a set of principles, some of which appear counter-intuitive and question the implicit theory that there would be an 'optimal' complexity for the plausible promise. This study has shown that the initiating actor does not need to provide a very specific technical description of the initial issues or the possible outcomes of collective action to get stakeholders involved. In some cases, such knowledge can improve technical realism, but the actors also largely rely on non-technical factors to decide whether or not they will join a dialogue. Mainly for this reason, in our case study, the credibility of the initiating discourse was poorly correlated with its ability to enroll stakeholders in the dialogue. This suggests that action can easily and rapidly be initiated if the actors share a cultural background in which the benefits of collective management do not require a concrete demonstration. However, this study does not allow to specify whether this is possible in a wide range of situations, or whether this leads to efficient actions in terms of increasing sustainability. This article illustrates novel opportunities to improve the sustainability of sociotechnical

systems, both through recommendations for dialogue implementation and through the identification of new critical research questions.

CRediT authorship contribution statement

Nicolas Bijon: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Tom Wassenaar:** Conceptualization, Methodology, Writing – review & editing, Supervision, Resources, Project administration. **Marc Vinches:** Validation, Resources, Writing – review & editing. **Magali Dechesne:** Writing – review & editing, Resources, Supervision, Project administration. **Guillaume Junqua:** Conceptualization, Validation, Resources, Writing – review & editing, Supervision, Project administration.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Veolia Research and Innovation (Employment as Industrial Ph.D. Student).

Appendix

A. Assessment of the plausible promises

During the session of the interviews dedicated to the assessment of the plausible promises, we played audio excerpts corresponding to these plausible promises were played to the interviewees in a specific order. Randomizing the presentation order was not possible because the contents of the promises build on each other. Specifically, D2 could not be presented before D1, and D3 could not be presented before D2 and D1, to maintain the coherence of the information. Furthermore, we had to consider the potential bias introduced by the prospective nature of S2 and S3 in evaluating less prospective scenarios S1 and S2. To address this concern, we consistently presented the plausible promises in the order depicted in Fig. 5.

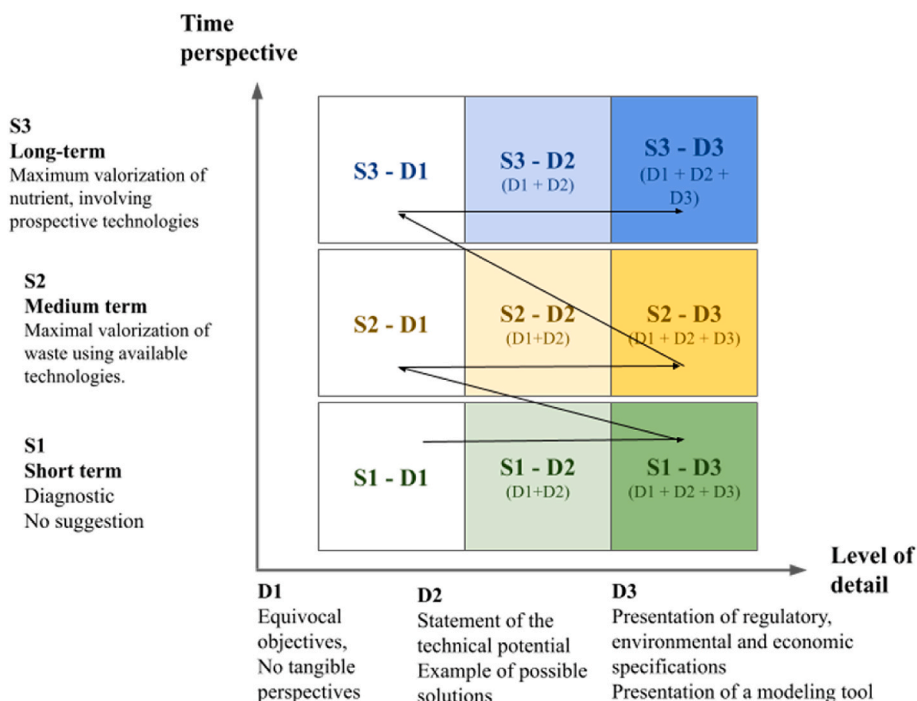


Fig. 5. Synthetic representation of plausible promises and order of their presentation during the interviews.

The recorded excerpts of the plausible promises contained dense information, which could cause challenges for interviewees in identifying and remembering key points. To address this issue, we employed symbol cards representing each argument with a symbol and/or a brief text, aiding interviewees in recalling the arguments presented. While they were listening, the cards revealed the argument stated in the excerpts, and provided additional information to the cards p shown. After each session, the cards were removed from the board. A color code associated with the sections was used on the cards, as shown in Fig. 5. All the cards are shown in appendix A.4. At the D3 level of detail, all the sessions introduced the potential use of a

Data availability

Data will be made available on request.

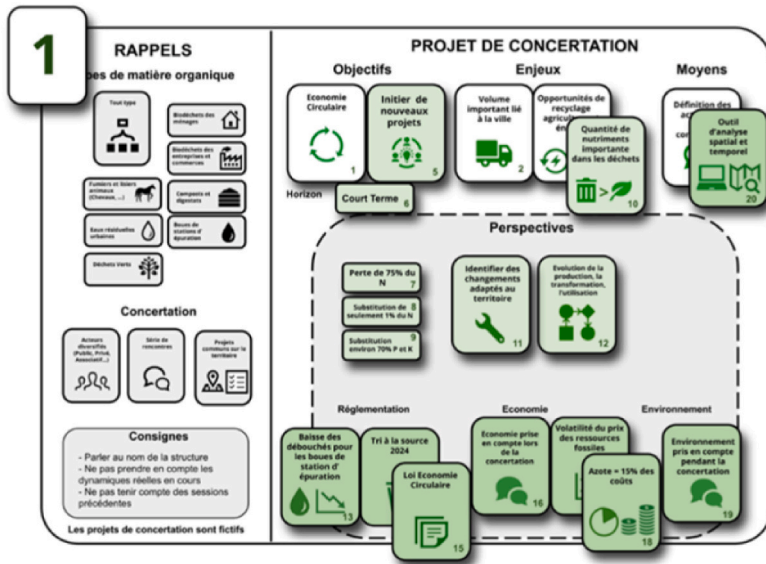
Acknowledgements

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well-informed dynamic modeling tool to facilitate the collective management stakeholder dialogue. This tool was depicted in an A4 image, of which an example is presented in Fig. 6-B (the three pictures are presented in appendix A.4).

A- Cardboard (session 1)

B- Image presented during the D3-level PP (session 2)



C- Assessment grid for one session (session 1)

Grille Session 1 / 3

| | | Très peu intéressé —————> Très intéressé | | | | | | | | | |
|-------------------------------------|------------------------|--|---|---|---|---|---|---|---|---|----|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Intérêt pour la concertation | Extrait 1 (1'06") | | | | | | | | | | |
| | Extrait 2 (1'45") | | | | | | | | | | |
| | Extrait 3 (2'05") | | | | | | | | | | |
| | Bilan Session Complète | | | | | | | | | | |
| | | Très peu réaliste —————> Très réaliste | | | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Réalisme de la proposition | Extrait 1 (1'06") | | | | | | | | | | |
| | Extrait 2 (1'45") | | | | | | | | | | |
| | Extrait 3 (2'05") | | | | | | | | | | |
| | Bilan Session Complète | | | | | | | | | | |

Fig. 6. Main material used during the interviews to assess the plausible promises.

At the end of each excerpt, respondents were instructed to complete an assessment grid, an excerpt of which is presented in Fig. 6-C (the complete grid is provided in appendix A.1). This grid enabled independent scoring of the interest and realism of each plausible promise on a discrete scale ranging from 1 to 10—1 meaning a low level of interest/realism, 10 meaning a high level. In this grid, we considered that the score given for “interest” approximates the performativity of the plausible promises expressed using a vocabulary that was familiar to the respondents – to fill this part of the grid, they were asked if they would actually join an initiative based on the preceding excerpt. At the end of each session, the respondents were asked to give a realism and interest score for the entire session.

1.1 Full text of plausible promises

The sessions are designed to be independent, meaning that each plausible promise containing D1 introduced a distinct collective management project. However, within each session, the information presented in the three levels of detail is cumulative. In other words, a more detailed plausible promise builds upon a preceding less detailed plausible promise. This implies that D2 actually corresponds to D1+D2, and D3 corresponds to D1+D2+D3. In addition, the introductions to all the sessions were identical and served as a reminder for the interviewees. They were informed that the plausible promises represented hypothetical but possible outcomes in terms of collective management. Additionally they were informed that the – imaginary - stakeholder dialogue would provide ample opportunities for them to contribute to the design of the most appropriate solution.

Level of detail D1

Full text of the audio excerpts corresponding to the level of detail D1 in the three sessions

| | S1 | S2 | S3 |
|--|--|--|---|
| Length | 1'06 | 1'24 | 1'18 |
| Introduction of the initiating actor | Hello, my name is M. Alain/Bernard/Charles. I'm researcher from the "Environment and Territory" unit. | We have been conducting studies on the Plaine de Versailles region, and would like to invite your organization to join in a collective dialogue. | We observed that the organic waste of the region has the potential to become valuable resources, particularly for agriculture. By collectively assessing the biomass flows at the regional level, we can explore opportunities to promote bioeconomy [S3-1]. |
| Objective (ill-defined) | We conducted a diagnostic assessment of organic waste in the <i>Plaine de Versailles</i> . Based on our findings, we believe there is an interesting potential to develop a more circular economy [S1-1] in the region, namely in relation with the management of these organic waste. | In the region, we identified an interesting potential for transforming the organic waste of some actors into valuable resources for others. This approach has the potential to simultaneously enhance both the environmental and economic performances of the region [S2-1]. | |
| Short qualitative description of the situation | They represent an important volume mainly due to their proximity to the city [S1-2]. Moreover, they have the potential to be an important resource. Indeed, they could be better utilized in agriculture replacing certain synthetic fertilizers, or contribute further to renewable energy production [S1-3]. | We observed that there is a significant amount of organic waste in the region that is either not being recycled, or could be better utilized, resulting in a loss of value for the region [S2-2]. For instance, some waste is currently being treated at distant location, whereas there are local treatment solutions that could supply nearby outlets [S2-3]. | Modern agriculture heavily relies on nonrenewable resources to fulfill its nutrient requirement, while those very same nutrients are being discarded in the organic waste generated by the region, particularly in urban areas. Considering that agriculture plays a vital role in ensuring food security, and has the potential to provide bio-based products, it is crucial that it reduces its dependence on fossil resources [S3-2], especially when there is a nearby reservoir readily available. |
| Non explicit collective action perspectives | To improve the value of these wastes, we propose initiating a dialogue [S1-4] among all the stakeholders involved in the management of organic waste. Together, we can develop a collective action plan at the regional level. | This situation could be improved by creating more synergies among the stakeholders, particularly by leveraging existing treatment and recycling solutions within the region, that could be further developed or optimized [S2-4]. To achieve this, it is crucial to initiate a dialogue at the regional level, allowing everyone to express their needs and identify the resources of others [S3-5]. This would ensure that the different channels do not work against each other but instead work in synergy. | Therefore, we propose to prioritize this issue and initiate a dialogue among various stakeholders of the region. The objective is to transform the organic waste management system [S3-3], ensuring that it aligns at best with the needs of the actors in term of final products they seek. |
| Reminder on the collectivedialogue process | During this dialogue, everyone will have the opportunity to share their ideas and expectations, and all the possibilities shall be discussed. | | |

Level of detail D2

Full text of the audio excerpts corresponding to the level of detail D2 in the three sessions

| | S1 | S2 | S3 |
|--|--|---|---|
| Length | 1'45 | 2'12 | 2'30 |
| Introduction Objectives (well defined) Defined objectives, | Here are some precisions and perspectives linked to this dialogue. We propose to conduct a collective assessment of the current situation, to initiate new projects and dynamics [S1-5] at short term [S1-6], and enhance the recycling of organic waste. | The objective would be to analyze the potential of each type of waste in the region, and to determine the most relevant method of treatment or recycling [S2-6]. This would enable the identification of synergies in the medium term, according to the possibilities and resources available to each stakeholder. | The objective would be to collectively determine the best pathway to engage in today in order that, in the long term [S3-4], local agriculture can operate without nonrenewable resources [S3-5], through the resources available within the OW of the region. |
| Accurate description of technical potential | We focused for instance on the essential nutrients for agriculture that are nitrogen, phosphorus and potassium, in the region. Regarding nitrogen, we identified that 1300 tons are used in the fertilizers in agriculture, while the OW generated in the region contain around 2000 tons [S1-7]. However, we estimated that 75% of this nitrogen is discarded during the treatment of these waste [S1-8], or exported outside the region. Consequently, only 1% of the nitrogen used in agriculture is currently derived from recycling [S1-9]. The recycling rates for phosphorus and potassium are higher, reaching around 70% [S1-10], but there are still enough resources to achieve self-sufficiency. | We made simulations and discovered promising possibilities for the recycling of OW. For instance, we evaluated that it was possible to meet the region's agricultural demand for phosphorus and potassium [S2-8], and to increase the nitrogen recycling by sevenfold [S2-9]. It would also be possible to double the production of renewable energy [S2-10], and to store additional 25% carbon in the soils [S2-11], which maintains their fertility. | We made simulations and discovered promising possibilities for the recycling of OW. In our most ambitious simulations we estimate that it would be feasible to substitute approximately 600 tons of nitrogen with the waste management system, that would account for roughly 50% of the current needs [S3-6]. These needs are expected to decrease in future as the trend towards organic agriculture continues. As for phosphorus and potassium, it would be possible to meet the entirety of crop needs [S3-7]. Besides, we could at the same time expect the production of 39 GWh of renewable energy, representing a six-fold increase compared to current production levels [S3-8]. |
| Statement of technological perspectives | The dialogue could result in the implementation of new collective projects driven by a shared understanding of the challenges in the region [S1-11]. Waste producer, for example, could utilize new channels for waste management. Those responsible for waste treatment could adapt their processes to ensure that the final residues are better suited for local utilization. Finally, the | To achieve that, we could consider a range of complementary solutions. For example, if not already implemented, anaerobic digestion could be used for wastewater sludge treatment [S2-12]. Another example, the horse manure that is currently exported from the region could be directed to a local composting facility [S2-13]. Household OW could be managed through a | We identified that the main nutrient source in the region are the wastewaters, particularly urines. To harness this largely untapped source of nutrient, it would probably be necessary to consider changes in the sanitation system [S3-9]. For instance, the separate collection and treatment of urine could facilitate its recycling. Otherwise, the wastewater treatment using |

(continued on next page)

(continued)

| | S1 | S2 | S3 |
|---|---|--|---|
| Length | 1'45 | 2'12 | 2'30 |
| | actors capable of using OW as raw material could express their expectations and their preferences, enabling their integration at an earlier stage in the treatment process and ensuring their final utilization [S1-12]. | combination of source reduction through small-scale composting and separate collection, allowing for centralized composting or anaerobic digestion [S2-14]. It would also be beneficial to incorporate OW generated by businesses in these channels. An advantage of anaerobic digestion is to combine energy production and nutrient recycling. These treatments could be carried out in existing infrastructures, or through the implementation of new projects in the region. Simultaneously, through the dialogue, it would be possible to collaborate the agricultural sector to identify the required properties of composts and digestates, and the best recycling processes [S2-15]. Beyond field crop, this would extend to market gardening, and the sale of compost in garden centers providing higher economic benefits. | microalgae could capture the nutrients, instead of eliminating them. Obviously, the solid part of OW also represent an important source, especially household OW that is not currently collected separately. Exploring synergies with all the other OW [S3-10], such as green waste, or horse manure, would be necessary. To facilitate agriculture use, an interesting approach is the nutrient extraction [S3-11], that requires a step of anaerobic digestion. |
| Reminder on the collective dialogue process | Our studies show the existence of a significant potential, but there is still work to be done with the stakeholders of the region. All solutions can be valuable and complementary, and we rely on your participation to identify the most relevant ones. | | |

Excerpts of detail D3 dialog excerpts corresponding to the level of detail D3 in the three sessions

| | S1 | S2 | S3 |
|---|--|---|--|
| Length | 2'05 | 2'16 | 2'40 |
| Introduction | We also considered other challenges related to this type of project. | | |
| Regulatory specifications | On a regulatory standpoint, the dialogue could help identify solutions that align with current changes. For instance, in the context of OW recycling, regulations promoting circular economy may prioritize the return of nutrients to the soil [S1-13]. In contrast, certain materials such as wastewater sludge, despite their agronomic value, will be more difficult to spread [S1-14]. Another example, the source separation of organic waste will be mandatory in 2024 [S1-15], which necessitates the development of solutions and outlets for these wastes within a relatively short timeframe. | On a regulatory standpoint, there are public support measures [S2-16] available for projects related to circular economy, biomass management, and renewable energy production, which could provide assistance for this type of initiative. Specifically, the development of anaerobic digestion [S2-17] is strongly encouraged. There are support programs for new projects, and the selling of biogas or electricity generated through anaerobic digestion. Additionally, regulatory changes facilitate the spreading of digestates from anaerobic digestion [S2-18], with the possibility of granting them an end-of-waste status, thereby promoting their effective recycling. | On a regulatory standpoint, there is some uncertainty regarding possible changes in the sanitation system. However, if new treatment processes prove to be as efficient as existing ones, local experiments could be considered [S3-12]. The issue of urine separation for instance [S3-13], is part of the climate change adaptation strategy of the Seine-Normandy Water Agency, leading in research and experimentation programs. In terms of solid OW management, there are many public policies [S3-14] that could support the project, and particularly anaerobic digestion, which improves nutrient availability [S3-15]. Nutrient extraction techniques are mature processes that allow to recycle nutrients as products, making them more marketable and facilitating their use in agriculture. |
| Economic specifications | On an economic standpoint, changing the waste management system brings forth certain considerations. The advantage of engaging in a dialogue is that it allows for the consideration of constraints faced by various stakeholders [S1-16]. Additionally, it is worth noting that the current situation presents significant economic risks, particularly for the agricultural sector. In fact, synthetic fertilizers account for a substantial part of farms' costs, approximately 15%. These costs are closely tied to the price of natural gas, a non-renewable resource [S1-17]. The volatility of these price which we can often observe, especially in the current context [S1-18], poses a constant threat on agriculture. | We also examined the economic viability of such projects. Based on our simulations, it appears that there is a potential to generate an additional 75% value [S2-19] with newly generated by-products. As a result, the cost of waste management would remain stable or even decrease if the solutions are optimized. Initial investment costs remains limited [S2-20], and there is the possibility of accessing the public subsidies mentioned earlier. | On economic aspects, we acknowledge the limited viability of this type of scenario in the current conditions, and we estimated that the management cost could increase initially. However, these conditions could significantly change in the future with the increasing scarcity of fossil resources. The cost of technologies may also decrease over time. It is crucial to integrate these long-term prospects into the vision for the region Anyway the actions will be implemented progressively and with flexibility [S3-16]. |
| Environmental specifications | The question also raises concerns on an environmental standpoint, because we are aware that no solution is perfect. We propose conducting a thorough estimation of the impacts associated with the projects developed during the dialogue, to ensure that the environmental criterion is duly con [S1-19]. | We also evaluated the potential impact of these changes from an environmental perspective. Taking into account various criteria such as greenhouse gas emissions, air pollution, and water pollution, we ha determined that the implementation of these changes would not result in an increase in environmental impacts [S2-21]. | There are also numerous uncertainties from an environmental standpoint, as we have observed that the significance of the implemented changes could potentially lead to additional impacts [S3-17]. This issue will be considered essential throughout the dialogue. |
| Presentation of a supposedly available, dynamic modeling tool | During the dialogue, it will of course be necessary to evaluate the advantages and drawbacks of different envisaged scenarios, particularly in terms of their long-term economic and environmental aspects for each stakeholder. To facilitate this evaluation, we can rely on a numerical modelling tool developed by our laboratory [S1-20; S2-22; S3-18]. | | |

(continued on next page)

(continued)

| | S1 | S2 | S3 |
|---|--|---|--|
| Length | 2'05 | 2'16 | 2'40 |
| Presentation of a supposedly available, dynamic modeling tool | (...) that already provides an accurate representation of the current situation on the <i>Plaine de Versailles</i> , as illustrated by these pictures [S1-IMG]. | This tool enables the representation of diverse evolution scenarios on the <i>Plaine de Versailles</i> , and the calculation of indicators that consider multiple factors, as illustrated by these pictures [S2-IMG]. | This tool has the capability to depict prospective evolution scenarios on the <i>Plaine de Versailles</i> , incorporating innovative solutions, and to calculate indicators that consider multiple factors, as illustrated by these pictures [S3-IMG]. |
| Reminder on the collective dialogue process | As you can see, there are still many aspects to be determined in order to implement these changes. Your participation will ensure that the challenges that you face are well considered and addressed. | | |

1.2 Interview Guide

Part 1: Open questions.

- Could you begin by presenting your professional background and your current job? Could you tell me more about your structure?
- What type of Organic waste do you use/treat/produce/manage in your current activity? How do you manage them? Is it satisfying? What problems do you face?
- There are sometimes stakeholders meetings for exchange or work on specific topics. Have you already participated in one of them as a guest or organizer? What are your links with the other stakeholders of the region?
- If you were offered the opportunity to participate in a dialogue on the management of organic waste without any further details, would you be interested in joining?

Part 2: Simulation. After each session.

- How did you react to each of these excerpts? What were the most significant elements for you? When and why did you change your score?

In the end.

- Among these three sessions, which session do you believe would be the best to initiate a stakeholder dialogue?

Conclusion.

- According to you, under what circumstances would this type of project be likely to start up?
- Are there any important aspects that you have considered but were not mentioned during the excerpts or the interview?
- According to you, what role should research and numerical tools play in the initiation and facilitation of stakeholder?

1.3 Full assessment grid for plausible promises

Grille Session 1 / 3

Très peu intéressé Très intéressé

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------------|---|---|---|---|---|---|---|---|---|----|
| Extrait 1 (1'06") | | | | | | | | | | |
| Extrait 2 (1'45") | | | | | | | | | | |
| Extrait 3 (2'05") | | | | | | | | | | |
| Bilan Session Complète | | | | | | | | | | |

Très peu réaliste Très réaliste

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------------|---|---|---|---|---|---|---|---|---|----|
| Extrait 1 (1'06") | | | | | | | | | | |
| Extrait 2 (1'45") | | | | | | | | | | |
| Extrait 3 (2'05") | | | | | | | | | | |
| Bilan Session Complète | | | | | | | | | | |

Assessment grid provided to the respondents (1/4) : assessment of session S1

Grille Session 2 / 3

Très peu intéressé Très intéressé

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------------|---|---|---|---|---|---|---|---|---|----|
| Extrait 1 (1'24") | | | | | | | | | | |
| Extrait 2 (2'12") | | | | | | | | | | |
| Extrait 3 (2'16") | | | | | | | | | | |
| Bilan Session Complète | | | | | | | | | | |

Très peu réaliste Très réaliste

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------------|---|---|---|---|---|---|---|---|---|----|
| Extrait 1 (1'24") | | | | | | | | | | |
| Extrait 2 (2'12") | | | | | | | | | | |
| Extrait 3 (2'16") | | | | | | | | | | |
| Bilan Session Complète | | | | | | | | | | |

Assessment grid provided to the respondents (2/4) : assessment of session S2

Grille Session 3 / 3

| | | Très peu intéressé → Très intéressé | | | | | | | | | |
|-------------------------------------|------------------------|--|---|---|---|---|---|---|---|---|----|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Intérêt pour la concertation | Extrait 1 (1'18") | | | | | | | | | | |
| | Extrait 2 (2'30") | | | | | | | | | | |
| | Extrait 3 (2'40") | | | | | | | | | | |
| | Bilan Session Complète | | | | | | | | | | |

| | | Très peu réaliste → Très réaliste | | | | | | | | | |
|-----------------------------------|------------------------|--|---|---|---|---|---|---|---|---|----|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Réalisme de la proposition | Extrait 1 (1'18") | | | | | | | | | | |
| | Extrait 2 (2'30") | | | | | | | | | | |
| | Extrait 3 (2'40") | | | | | | | | | | |
| | Bilan Session Complète | | | | | | | | | | |

Assessment grid provided to the respondents (3/4) : assessment of session S3

Synthèse des sessions

| | | Classer de 1 à 3 | |
|-------------------------------------|-----------|------------------|--|
| Intérêt pour la concertation | Session 1 | | |
| | Session 2 | | |
| | Session 3 | | |

| | | Classer de 1 à 3 | |
|-----------------------------------|-----------|------------------|--|
| Réalisme de la proposition | Session 1 | | |
| | Session 2 | | |
| | Session 3 | | |

Assessment grid provided to the respondents (4/4) : comparison between sessions

1.4 Cards and pictures presented during the interviews

Session 1



Cards used during session S1. Translation : 1. Circular Economy; 2. Important volume due to the city; 3. Recycling opportunities in agriculture and energy; 4. Definition of the actions to be taken through collective management; 5. Initiating new projects; 6. Short term; 7. High amount of nutrient in wastes; 8. 75% N loss; 9. Only 1% N substitution; 10. Around 70% P and K substitution; 11. Identify changes relevant for the region; 12. Evolution of the production, process and use; 13. Law on Circular Economy; 14. Fewer outlets for sewage sludges; 15. Source separation in 2024; 16. Taking economy into account with the collective management; 17. Nitrogen = 15% of the costs; 18. High variability of the price of fossil resources; 19. Taking environment into account with the collective management; 20. Spatial and temporal analysis tool.

Outil de Modélisation - SESSION 1

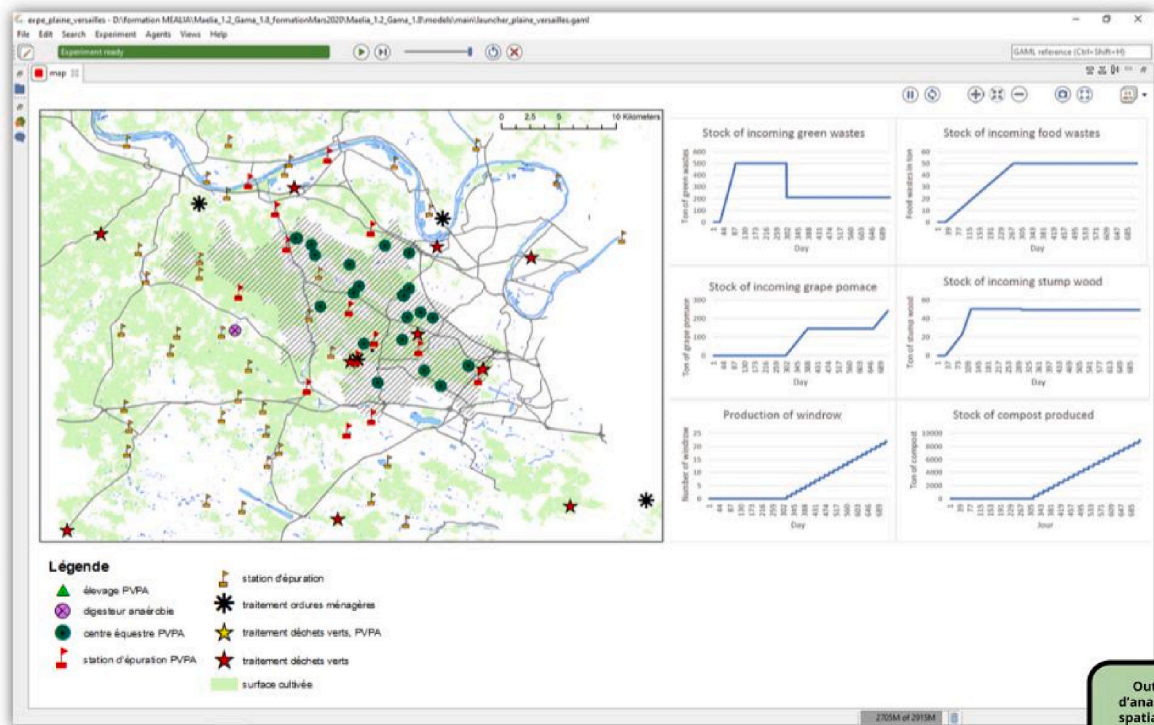
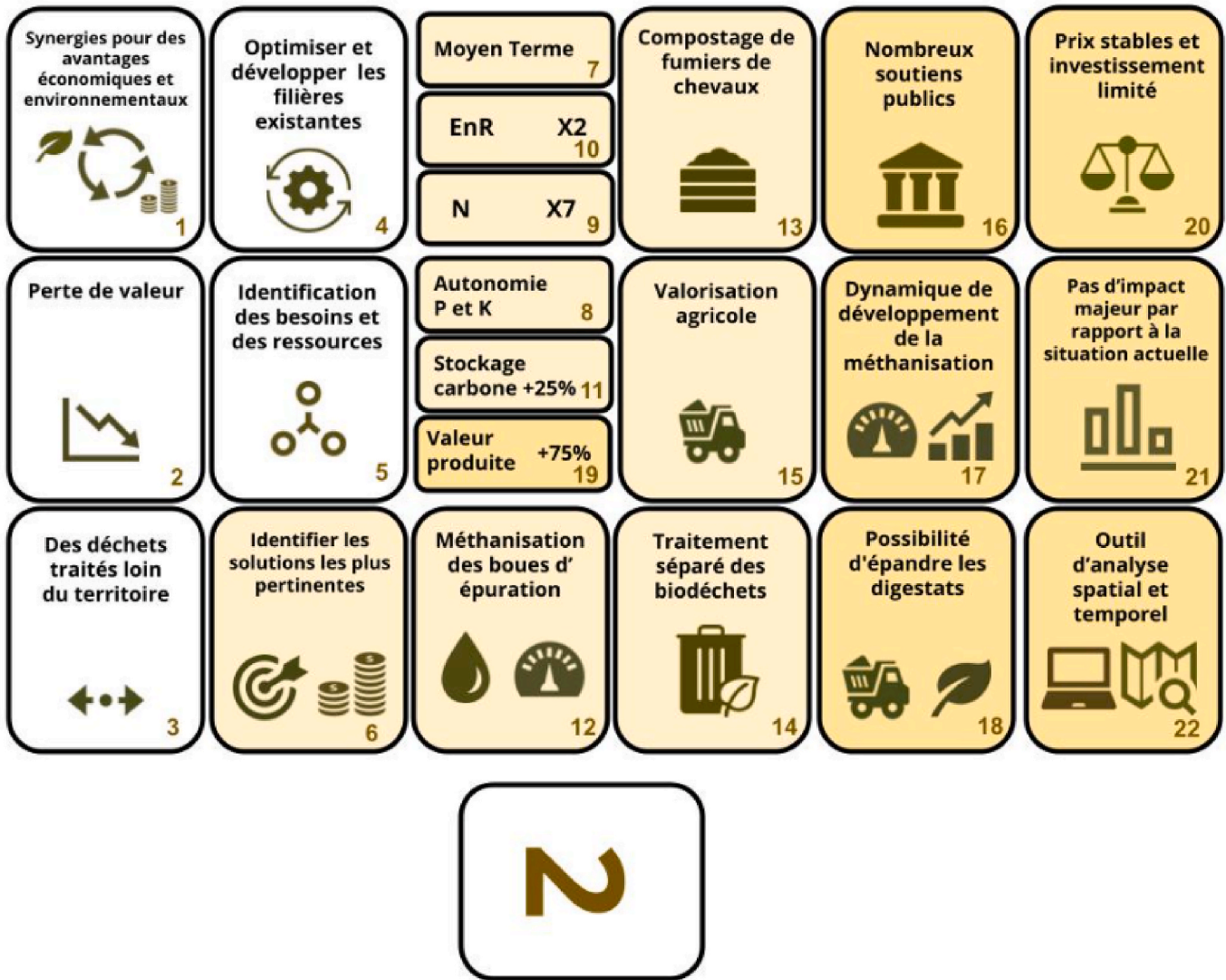


Image shown along with the card #20 (Spatial and temporal analysis tool) during session S1.

Session 2



Cards used during session S2. Translation : 1. Synergies for economic and environmental advantages; 2. Value loss; 3. Waste processed far from the region; 4. Optimize and develop existing pathways; 5. Identification of needs and resources; 6. Identify the most relevant solutions; 7. Medium Term; 8. P and K autonomy; 9. N multiplied seven-fold; 10. Renewable energies doubled; 11. +25% carbon storage; 12. Anaerobic digestion of sewage sludge; 13. Composting horse manure; 14. Separate pathway for biowaste; 15. Agricultural use; 16. Numerous public support; 17. Dynamism of anaerobic digestion pathways; 18. Possibility to spread digestates; 19. +75% Produced value; 20. Limited investments and steady prices; 21. No significant impact compared to current situation; 22. Spatial and temporal analysis tool.

Outil de Modélisation - SESSION 2

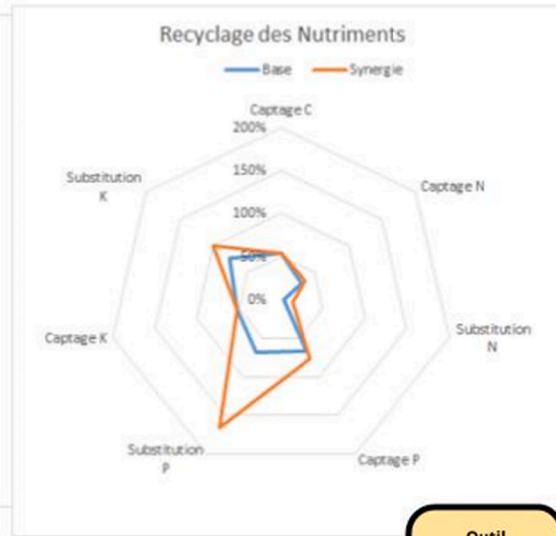
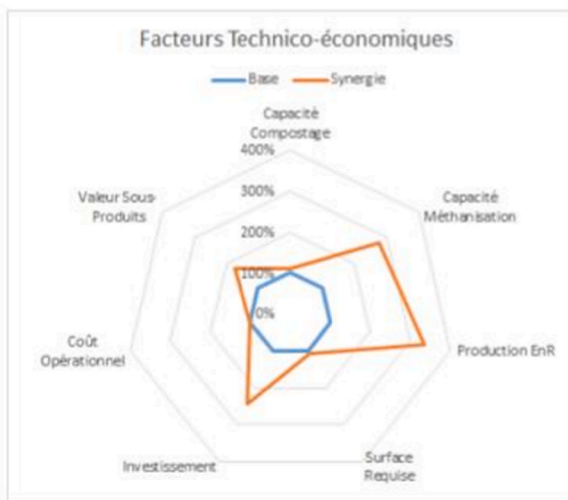
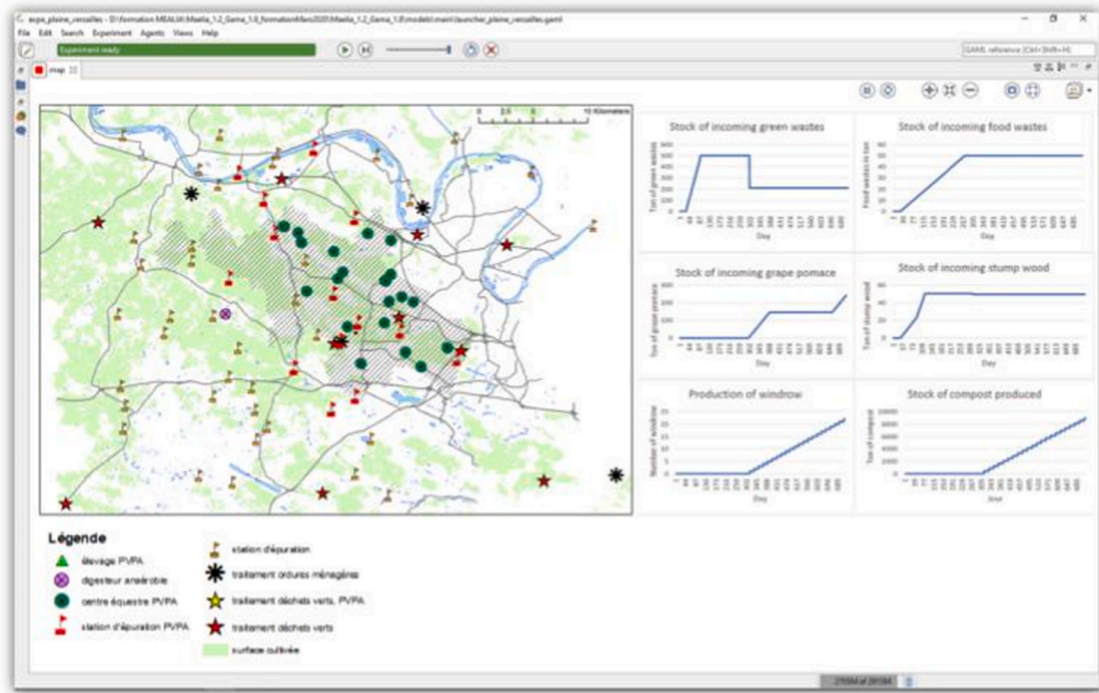
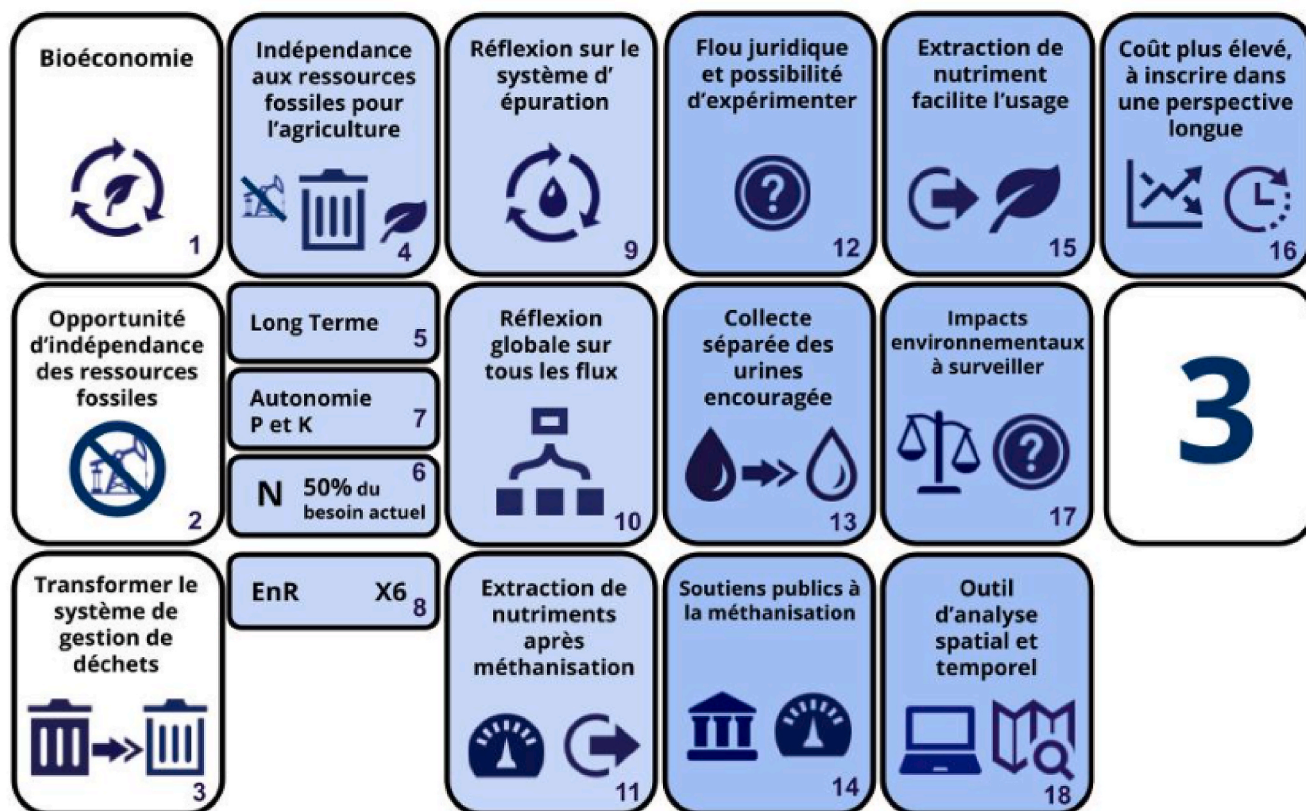


Image shown along with the card #22 (Spatial and temporal analysis tool) during session S2.



Cards used during session S2. Translation : 1. Bioeconomy; 2. Opportunity for fossil resources independence; 3. Transforming the waste management system; 4. Independence from fossil resources in agriculture; 5. Long term; 6. 50% of current N requirement; 7. P and K autonomy; 8. Renewable energies multiplied six-fold; 9. Examination of the sanitation system; 10. Global thinking on all flows; 11. Nutrient extraction after anaerobic digestion; 12. Possibility for experiments due to legal vagueness; 13. Source separation of urines; 14. Public support to anaerobic digestion; 15. Nutrient extraction facilitates the use; 16. Higher cost to consider in long term outlook; 17. Environmental impacts to be watched for; 18. Spatial and temporal analysis tool.

Outil de Modélisation - SESSION 3

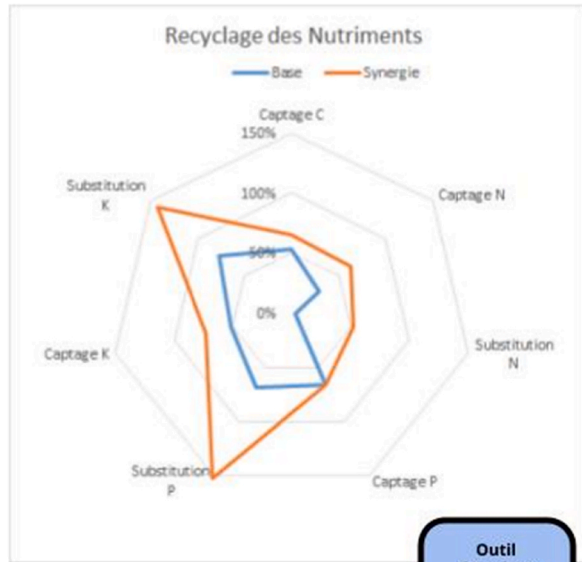
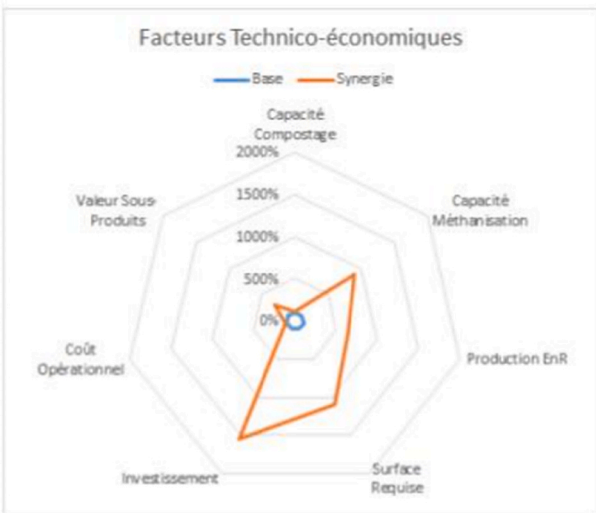
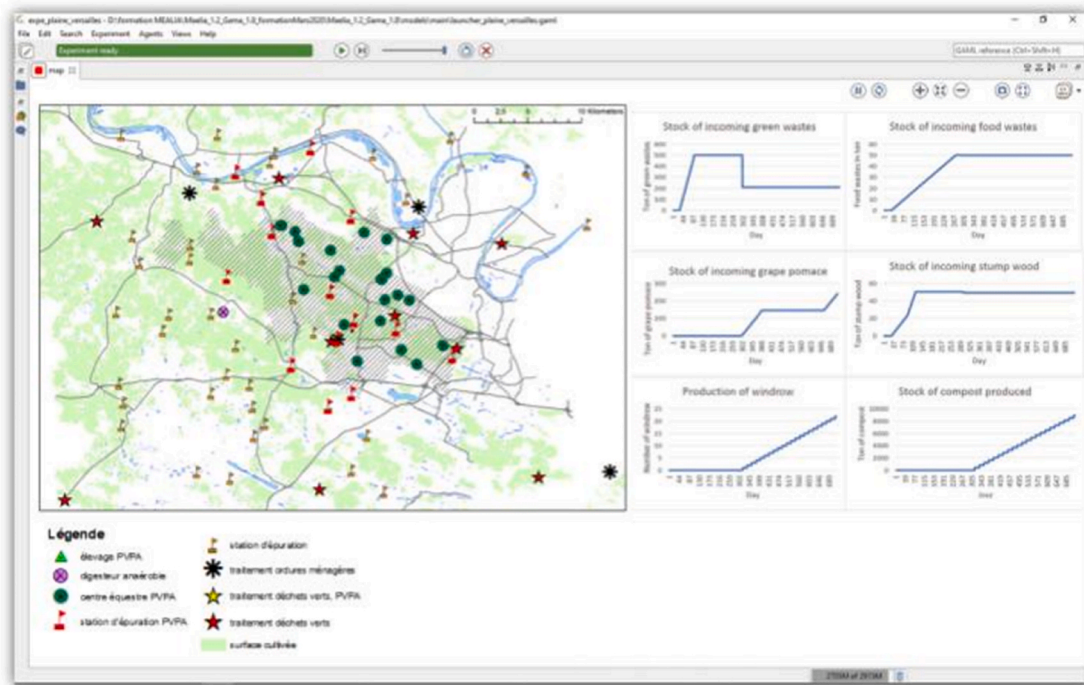


Image shown along with the card #18 (Spatial and temporal analysis tool) during session S3.

B. Qualitative assessment of the interest to join the collective action without PP

During the interviews and before giving grades to the plausible promises, the interviewees were asked about their interest in joining a collective management initiative without providing any specific information about the context. This was done to test hypothesis (H1) (see 1.5). The analysis of these initial answers was done qualitatively, as no numerical assessment of interest was done during this part of the interviews. The qualitative framework developed in section 3.2 allowed for the understanding and classification the answers to this assessment and is summarized in Table 4. Out of the 19 actors interviewed, 11 showed a positive interest in participating in a collective management action, while only 2 had a negative opinion. The main object of interest expressed by the actors were the potential outcomes, namely the strategic interest for their structure (6) and the interest for mutual knowledge (3). Uncertain answers were mostly related to the actors' perspectives, as they wanted more information about the possible outcomes before declaring to be interested. The following statement illustrate for instance this type of reaction:

It's like anything else, it depends on what the topic is but yes, why not. If we talk about a waste treatment platform, if it is about waste, yes, but it is still necessary that it is in line with our core activity.

Regulation stakeholder, January 2022

Without providing any context, the initial issues may be sufficient to attract the interest of the actors (3) or, on the contrary, lead to their withdrawal (1).

Table 4
Qualitative assessment of the interest to join in a collective dialogue by the stakeholders before the simulation exercise

| Jugement | Nombre (N = 19) | Future outlook | Initial stakes | Process |
|---------------------------|-----------------|----------------|----------------|---------|
| Positive | 11 | 9 | 3 | |
| Dépendants on the context | 5 | 4 | | 1 |
| Negative | 2 | 1 | 1 | |

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