Public policy design: Assessing the potential of new collective Agri-Environmental Schemes in the Marais Poitevin wetland region using a participatory approach

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Abstract

The conciliation between different issues such as agriculture production, biodiversity conservation and water management remains unsolved in many places in the world. As a striking example, the wet grasslands of the Marais Poitevin region (France) presents many obstacles against the integration of these issues, especially in terms of public policy design. The socio-cultural situation in this region shows a high degree of political resistance and questions the relevancy of the current Agri-Environmental Schemes (AES) as an incentive for livestock farmers to adopt biodiversity friendly practices favoring the birds' richness of the area. In this study, we explored the reasons for the poor effect of public policy using a two-fold approach based on ethnographic fieldwork and a role-playing game experiment. The ethnographic fieldwork aimed at understanding the local context and daily lives of farmers and current AES's difficulties while the observation of the role-playing game session allowed for the exploration of current and alternative policy scenarios. The game represents an archetypal wetland that simulates the grass regeneration, water flows through a canal system and a surrounding network of cultivated plots (wheat, corn, sunflower, alfalfa) and pasture areas. The game is designed for eight players who embody their role in real life, i.e. water managers, biodiversity managers and farmers. The behaviors of the players during the session were observed and analyzed through semantic analysis. The game was structured around two scenarios to allow participants to explore, test and compare the current individual action-oriented AES with alternative collective public policy instruments. Such comparison brings new insights for public policy design. It also highlights the topic of integrated environmental

management and questions the relevancy of participatory approaches in striving to resolve contradiction/dilemmas in environmental development.

Keywords: cooperation, agriculture, wetlands, role-playing game, biodiversity, trade-off, public policy, Agri-Environmental Schemes.

1. INTRODUCTION

The intensification and homogenization of agricultural practices in Europe over the last decades has driven substantial landscape changes with direct negative effects on biodiversity (Tscharntke et al., 2005). Farmland birds species have been particularly affected (Donald et al., 2001), especially in areas where mechanization, intensification and land consolidation triggered habitat degradation and/or loss (Vickery et al., 2001). However, in the specific context of grasslands, agricultural activities such as extensive grazing and occasional mowing are essential for the maintenance of suitable bird habitat (Donald et al., 2002; Sabatier et al., 2014). In such cases both management intensification and abandoning management (desertification) can lead to biodiversity loss (Simons et al., 2017). This also applies to wetlands where interdependencies between cropping areas, pastures, water levels and bird species richness are creating a complex landscape of competing uses and synergies.

In France, wetlands were the first habitats targeted by environment schemes during the early 90’s (Sabatier et al., 2012). Those public policies, known as “action-based” Agri-Environment Schemes (AES), aim at engaging farmers in more sustainable practices to protect biodiversity. They focus on the delivery of land management practices and not on the provision of outcomes (Burton and Schwarz, 2013). They have been implemented as a mechanism to financially compensate farmers for the loss of income associated with less intensive forms of grassland management (Batáry et al., 2015). Those incentives reward sustainable practices such as fertilizer reduction, cattle density limitations, and mowing period restrictions.

However, 15 years after implementation, the effectiveness of AES is still under debate (Kleijn et al., 2006; Riley et al., 2018). In their review, Kleijn and Sutherland (2003) concluded that about half of the schemes did not increase species richness. One of the reasons is that farmers' participation, which is key to ensure success, remains very often too low to achieve tangible biodiversity results (Lastra-Bravo et al., 2015; Kuhfuss et al., 2016; McKenzie et al., 2013). Those measures are now being criticized for reinforcing rather than cancelling the opposition between agricultural production and environmental protection (de Krom, 2017). Indeed, in the Marais Poitevin, in France, the current AES reduce the sets of practices and induce economic limitations; farmers lose money when committing in AES (Schwarz et al., 2008).

An alternative to current AES would be the implementation of result-oriented AES payments, where the payments are conditional on positive biodiversity conservation outcomes, independently of farmers management practices (Sabatier et al., 2012). Such schemes have been widely tested but are still at the experimental stages or implemented on too restrictive spatial or temporal scales to allow for a proper valuation of their effects (Schwarz et al., 2008).

In their study, Le Coent et al. (2014) used an experimental economics framework to compare an action-based subsidy (unconditional subsidy) with a result-based subsidy (conditional subsidy) and showed that the second mechanism is more efficient and effective. In their experiment, conditionality for payment was linked to an aggregated contribution at a collective level. However, this study was decontextualized, as participants were students and not real stakeholders. Moreover, the experimental economics framework depicted in the study, where all parameters are strictly controlled, leaves little room for innovation and creativity from participants to invent alternative scenarios.

More recently, Groeneveld et al. (2019) explores the impact on biodiversity when switching from individual to collective application of AES using mathematical modelling. They highlight that the land use system is less resilient under the collective scheme, but warn against generalization as their model is based on a small sample of farmers and rely on strong hypothesis behind their decision-making process. Moreover, these authors mention the fact that, since the change in paradigm from individual to collective AES is rather new, scientific data to analyze it is not yet widely available.

Today, scientific and political arenas question not only the choice of an action-based subsidy but also at a higher level the effectiveness of the top-down approach to AES and their prescriptive nature that hinders long-term behavioral change (Arnott et al., 2019). There is a new call for innovative agri-environmental provision (de Krom, 2017) where the focus is placed at regional levels instead of top-down imposed (Böcher, 2008; Kneafsey, 2010). As Winter (1997) as already pointed out: "For too long the policy debate has been conducted with little reference to farmers or to their view of the world". Scientists are increasingly aware of the importance of farmers' participation in AES design. They acknowledge the existence of different sources of expertise and of representation of the environment (Mathieu, 2004; Mathieu and Remy, 2010), and many advocate for more proximal methods, based on local contexts.

The importance of understanding stakeholders' mental models – their conceptual representation of the world based on their experience, perception, and knowledge – for natural resource management is not new (see the review by Jones et al., 2011). Mental models are the basis on which individuals make decisions and take actions, and thus affect the way individuals interact with their environment. Eliciting the mental models of the multiple stakeholders involved may improve collaboration and management planning by a) strengthening communication and mutual understanding, b) integrating multiple sources of knowledge, and c) contributing to creating shared ownership, and d) identifying common ground and disagreements (Biggs et al., 2011). In sum, by enabling stakeholders to communicate their mental model with each other, social learning can occur and lead to a shared mental model providing a common framework of understanding and basis for actions (Mathevet et al., 2011; Schusler et al., 2003).

ComMod is a community-based scientific approach that emerged in the 1990s to facilitate collective action (Étienne, 2014). Using Multi-Agent Systems (MAS) and role-playing games, the aim is to facilitate dialogue between the different stakeholders and promote shared learning on environmental issues (Bousquet et al., 1999). This approach has been implemented for various agri-environmental issues and in a wide variety of contexts: groundwater management in the low-lying atoll of Tarawa (Dray et al., 2006); Watershed Management in Mountainous northern Thailand (Barnaud et al., 2007) ; forest management planning in the Causse du Larzac (Simon and Etienne, 2010) ; erosive runoff in the Seine Maritime (Souchère et al, 2010) ; game hunting management in Cameroon (Le Page et al., 2015) ; impacts of farming practices on trade-offs among ecosystem services in the Mont Lozère (Moreau et al., 2019). This approach is a powerful method to elicit and share mental models between multiple stakeholders (Mathevet et al., 2011). It offers an arena to test new public policies acceptability and explore prospective scenarios in a virtual world mimicking - to some extent - their realities.

Here, we propose to use a ComMod approach, coupled with ethnographic fieldwork (de Sardan, 2008), to explore in situ, new policy instruments with farmers in a biodiversity-rich wetland context, and track changes in mental models. In our study, we focused on the Marais Poitevin wetlands, a highly anthropized environment, combining cropping and pasture systems, where conservation of farmland bird biodiversity is at high stake. The observation of the players constitutes the core of this study.

Our objective with these combined approaches is to test actors' choices when facing two policy options (individual action-based VS result-based) in a role-playing game experiment. We explore the effects of these policy alternatives on the behaviors of the actors, including the setting-up of collective action and their semantic and mental models.

2. MATERIAL AND METHODS

2.1 Description of the case study

The study site is located on the French Atlantic coast and focuses on the Marais Poitevin wetlands (46°22′N, 1°25′W), the second biggest wetland of France and of major importance for biodiversity conservation (Pinton et al., 2006). This agro-ecosystem is dominated by a mosaic of cropping and grassland areas in two distinctive zones of wet and dry marshlands (Figure 1). It hosts more than 330 migratory and non-migratory bird species, many of which are dependent on very specific intensity of farming practices for the maintenance of suitable habitats. The main stakeholders and organizations in the area are:

- the farmers and their professional organizations,
- the nature conservationist with the Bird Protection League and the Wildlife and Hunting National Office managing the natural reserves
- the wetlands association ("Association de Syndicat de Marais") in charge of controlling water levels through sluice gates.

All of the above are coordinated on a regional level by the government-owned corporation ("Etablissement Public du Marais Poitevin") and the regional park who supervises the application of the AES in the region.

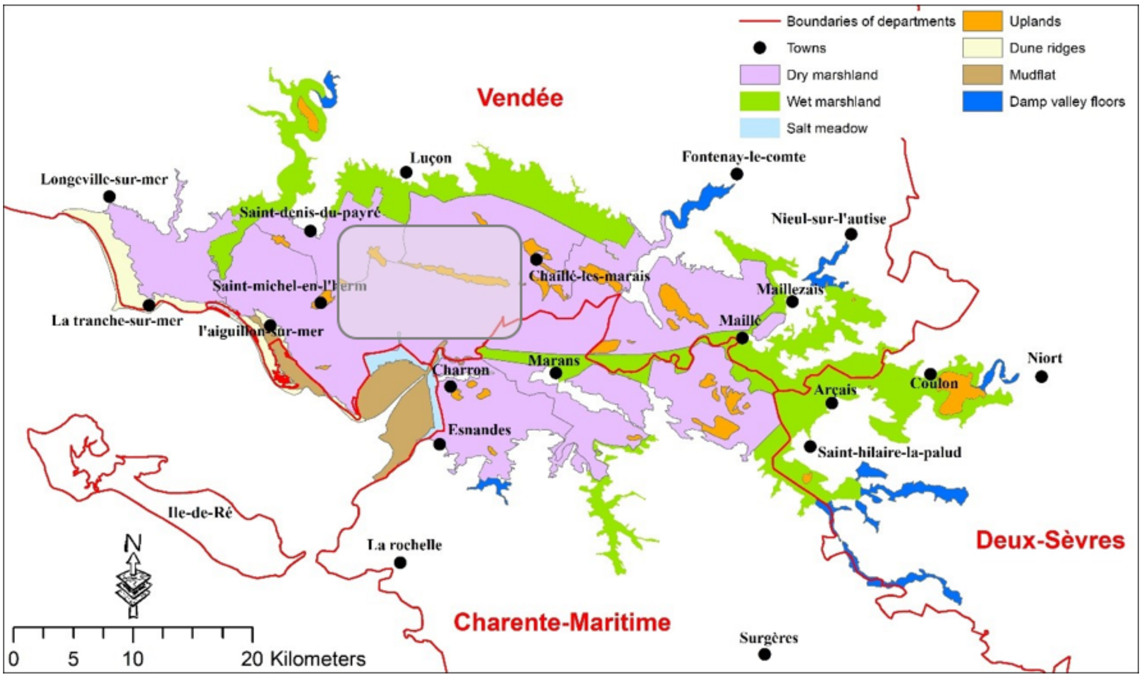

Figure 1: The Marais Poitevin region: in green the wet marshland, in pale pink, the dry marshland and in blue the salt meadow. The studied area is represented by a grey rectangle in the center of the dry marshland.

The selected area for the study (grey rectangle on Figure 1) is situated in the middle of several biological reserves ("Conservatoire du littoral" zone in the south, "Reserve de Saint Denis du Payré", one of the first bird reserve in France in the West and "Grand site de France" in the most humid part of the wetland in the East). This central zone presents the most illustrative situation in terms of bird conservation. Preliminary discussions with the regional park manager, the water management association and diverse NGOs and agriculture chambers active in the region helped gaining a first understanding of the local context and the farmers' organization. Based on those meetings, we identified this representative area of 15km x 10km surrounded by the abovementioned biological reserves.

After a historical period of livestock breeding dominance (Derex, 2001), the mechanization of agriculture in the last century allowed the progressive implementation of crop rotation (wheat, corn, sunflower), leading to an increase in the number of pastures being tilled. The resulting rapid decline in grassland areas (Duncan et al., 1999) together with an overall intensification of farming practices led to a severe degradation of the environment (Billaud, 1986). In an effort to protect the ecosystem, the region was labelled “natural regional park” (“Parc Naturel Régional du Marais Poitevin”) in 1979, but lost its designation in 1996 following the sharp decline in grassland areas (Charles, 2013). To protect biodiversity, top-down AES compensate farmers who mow late and reduce trampling from cattle to protect bird nesting on the ground. Despite these measures, almost 20 years of efforts and tillage ban, and two infringement proceedings for biodiversity loss from the European Union have been necessary for the park to regain its designation in 2014 (*Décret n° 2014-505 du 20 mai 2014 portant classement du Parc Naturel Régional du Marais poitevin (régions Pays de la Loire et Poitou-Charentes)*, 2014).

2.2 A ComMod approach including an ethnographic study

At the beginning of 2012, we proposed to local stakeholders in the Marais Poitevin area to think about the reconciliation of agricultural production and biodiversity conservation objectives at the scale of farms and agricultural territories using a Companion Modelling (ComMod) approach. ComMod is a community-based scientific approach that emerged in the 1990s to facilitate collective action (Etienne et al., 2014). Using Multi-Agent Systems (MAS) and role-playing games (RPG), the aim is to facilitate dialogue between multiple stakeholders and promote shared learning on environmental issues (Bousquet et al., 1999). This can be achieved through the collective construction of a common artificial world leading to the emergence of a shared representation of the complex system and problem in order to test new public policies acceptance and explore prospective scenarios.

21 people from different institutions (Associations for the protection of the environment, Farmers’ association, regional and local authorities, Regional and Natural Park of the Marais Poitevin, and wetland associations,) were invited by the scientists to several participatory workshops. Just over 50% of those invited did participate in at least one of the workshops and

worked together for five years. *Figure 1* shows the main stages in the study that are based on back and forth steps between the model and the field.

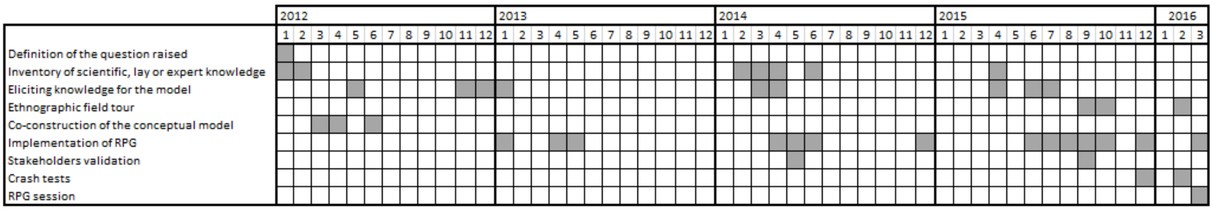

Figure 2: Step and timeline of the ComMod process

During the first half-day workshop in January 2012, three salient points were raised. Firstly, the local stakeholders strongly insisted that the question around the reconciliation of agriculture and biodiversity would encompass the issues on water levels' management, which are directly related to the availability and quality of the birds habitats. Second, they opted to focus the study on the dry marshland given the extent of its surface (almost 50% of the marsh surfaces). Furthermore, they considered that it would be easier to take better account of conflicts over water levels between different farmers (breeder vs cereal producer) while also showing that the preservation of biodiversity is not only the prerogative of breeders. Third, they discussed the type of tool (role-playing game or simulation model) that should be developed following the various workshops. The final choice led to favoring the role-playing game option for its very interactive aspect, allowing collective thinking to emerge while integrating the requirements of each other. At the end of this first workshop, the question chosen to guide the development of the conceptual model of the future role-play was: how to reconcile agriculture, bird biodiversity and water level management in dry marshland? Then, during three other one-day workshops in March, April and June 2012, we worked with the group to build the conceptual model of the role-playing game based on the ARDI method (Etienne et al., 2008). Our objective was to collectively identify the main stakeholders concerns with the issue of agriculture, bird biodiversity and water levels, the entities they manage and the main dynamics and interactions at play according to different temporal and spatial scales. At the end of these workshops, we had gathered all the elements needed to begin implementing the role-playing game called ‘‘BotNidVeau’’. Between November 2012 and March 2016, we alternated phases of RPG development, periods of inventory and clarification of knowledge available via surveys and literature reviews, and meetings and crash tests to validate the tool.

In parallel, we conducted an ethnographic study to get an in-depth understanding of the perception of AES by the Marais Poitevin farming community. We documented farmers behavior, social interactions and perceptions 1) in situ (which we hereafter refer to as the *ethnographic fieldwork*), and 2) during game sessions where the farmers played a role-playing game simulating their agroecosystem (which we hereafter refer to as the *ComMod approach*).

The ethnographic fieldwork was conducted by the first author in autumn 2015 and spring 2016. He immersed himself in the life of seven farmers living in the zonation depicted in the Figure 1 who were already involved in the ComMod process described in the previous paragraph. He spent altogether 33 days in the field, with the shortest stay being 1 day, and the longest stay being 10 days with the same farmer. He documented community members' actions, words, and environment through observations and (conversational) interviews to understand how the community makes sense of a given situation (Merriam 2002, Okely, 2013). The researcher introduced himself to the farmers as anthropologist working on the question of livestock breeding practices and its socio-economic consequences. During his immersion stays, he assisted the farmers with their daily activities. Farmers did not change their habits, nor their duties. They carried on with their usual activities, including feeding animals, repairing fences, and cleaning the stabling with the help of the researcher. Conversations arose naturally and farmers spoke freely on the topics of nature, birds, water, agricultural practices and public policies. He recorded his observations and impressions in a field diary. Particularly, he documented each farmer's relationship with other community members, his political reactions and feedback on AES, and his ecological knowledge. He evaluated the relationships between farmers based on what farmers said about each other, and the ecological knowledge of a farmer based on the farmer's understanding of birds (including the role of birds in the ecosystem, their seasonality, their feeding behavior, and the precise locations where they have been spotted)

2.3 Game Design

The game board and game mechanisms

The game board (Figure 3) represents an archetypal dry marshland divided into two wetlands associations. Each association is divided in four pools that communicate by sluice gates. Within each pool, grassland or cropland plots are attributed to players. The virtual landscape interlinks the dynamics of agricultural production, water management and farmland bird abundance. Water levels are collectively managed at the scale of wetland associations. Agricultural dynamics are managed by individual farmers. The biophysical processes represented in the game are water flow, grass growth, birds nesting and reproducing. Their specific dynamics, affected by climatic factors (rainfall) and players' decisions, are computed and updated in an associated agent-based model. Three bird species are included in the game to represent bird abundance and its interaction with farming practices: two grassland species, the Northern Lapwing (*Vanellus vanellus*) and the Common Redshank (*Tringa totanus*), and one cropland species, the Montagu Harrier (*Circus pygargus*). Their dynamics depend on direct cattle and/or mowing disturbances as well as habitat quality in terms of water and grass levels.

Roles and players' actions

The game is tailored for eight roles that can be played individually or in team of two:

- five mixed farmers (with both crops and cattle)

- one head of a wetland association ("Association de Syndicat de Marais"), who is also a crop farmer
- one head of a wetland association ("Association de Syndicat de Marais"), who is also a cattle farmer
- one nature conservationist in charge of a natural reserve.

One round in the game corresponds to a one-month period in reality. The game session simulates a three-year period. Players take active decisions for the spring season, namely the months of April, May and June. The computer simulates the rest of the months, using the inputs from the players during the above-mentioned spring season. During a round, players can perform a set of actions depending on their roles:

- Farmers can make decisions regarding the rotation of their crops (if any), the size and allocation of plot to cattle (if any), and the mowing date for their grassland (if any).
- Wetland association presidents can decide on water levels in the various marshland compartments
- The nature conservationist cannot perform any action on the board. He/she manages the natural reserve and promotes suitable conditions for nesting and breeding. He/she has to convince the farmers to allocate cattle to graze in the reserve to maintain grass height and to protect nests in their fields. He/she also needs to persuade the wetland associations' presidents to increase water level whenever necessary.

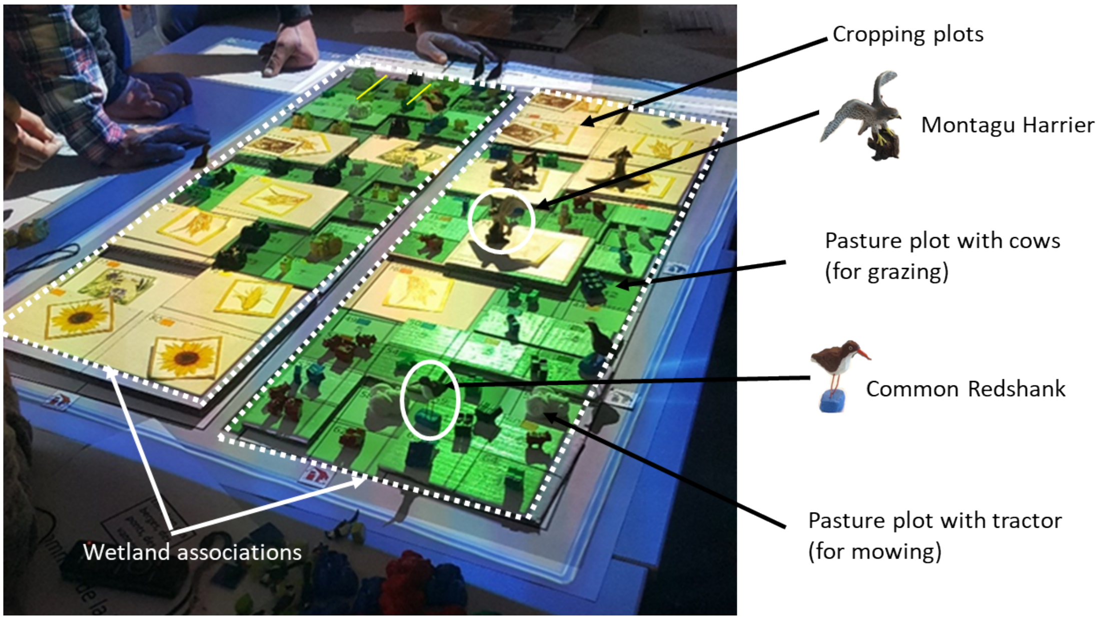

Figure 3: The game board around which players interact. The yellow areas represent the agricultural plots while the green ones represent the grassland plots (the darker the green the higher the grass height). The two zones delimited by white dotted line correspond to the two wetland' associations. Players decide individually or collectively about the number of cows and mowing machines per plot, the type of cultivated crops, the water levels settled by the wetland association presidents and the number of cows allowed by the nature conservationist to populate the grasslands of the nature reserve. The birds are also present and take the form of little figurines.

Players' targets

Players in the farmer' roles have to secure sufficient incomes at the end of the session. They start the game with a given amount of money based on their farming system and size, ranging from 5 to 80 money units (we used an imaginary currency called "mailles", calibrated against real figures). Players are provided with an information sheet along with economic data on the potential yield per crop and market prices. The economic data were derived from the ethnographic survey. The agent-based model compiles the economic outcomes of the players.

The nature conservationist aims for the highest possible bird populations. The wetland association presidents have no specific targets since they are driven by the targets of the other players and their own farmers' roles.

The AES in the game

The game can be played with one of two scenarios: individual action-based VS collective result-based AES.

During the morning session, the individual action-based AES was proposed (hereafter referred to as the classical scenario). Farmers can contract a "classical" individual action-based AES with special constraints on mowing dates and trampling restrictions through limited livestock units. No matter the results in terms of bird survival, if these conditions are fulfilled players get a fixed financial compensation of 3 money units.

In the afternoon session, we proposed two new public policies, with both a collective dimension and a result-based implication[1]: a "bonus AES" and a "free-form AES" (hereafter referred to as the alternative scenario). The "bonus AES" has been designed as a collective, action-oriented and result-based AES that aims to link player decisions to their effects on biodiversity indicators (in the game the birds). The collective action is here defined as a group arrangement of practices to achieve a common objective, i.e. a biodiversity result. If successful, the financial retribution is of 7 money units. The eligible condition for the extra payment is 1) to apply the constraints of the "classical" AES, 2) to work with a minimum number of three neighboring farmers, and 3) to reach a target of 20% fledging success. A group of three corresponds to more than one third of the total number of players and can lead to an observable consequence of collective action on the biodiversity indicators within the game.

As the "bonus AES" still maintains the "classical" constraints (namely lid mowing date and reduced unit livestock density), we also proposed another collective result-based AES ("free-form AES") with no action constraints at all to allow farmers to look for adaptation of

[1] Two collective AES have been proposed to the players, but as described in section 4.2.2, only the "free-form AES" was chosen. Therefore, only this latter policy could be fully explored in the role-playing game.

practices (Burton and Paragahawewa, 2011). On the one hand, the “bonus AES” gives a caveat to proceed a familiar system of constraints as a working base. On the other hand, the “free-form AES” does not accompany the farmers with a set of practices. It gives a large space to cope with an environmental aim but can potentially restrain farmers who may have problems proceeding from a blank page.

Table 1 summarizes the specificities of the three public policies available in the game.

	Classical scenario	**Alternative scenario**	
	Action-oriented AES	**Bonus AES**	**Free-form AES**
Players’ involvement	Individual	Collective (at least 3 farmers)	Collective (at least 3 farmers)
Constraints	Mowing date Trampling restrictions	Mowing date Trampling restrictions	none
Environmental objectives	none	+20% fledging success	+20% fledging success
Financial retributions	+3 money units irrespective of env. objectives.	+7 money units conditional upon achieving env. objectives.	+7 money units conditional upon achieving env. objectives.

Table 1: Comparative table across four dimensions (involvement, constraints, environmental objectives and financial retributions) of the three proposed AES in the game.

Running the game and data collection

The game sessions took place in March 2015 and lasted one full day. During the morning session, eight participants - the seven farmers who participated in the ethnographic study, and a nature conservationist, played the classical scenario. In the afternoon, the alternative scenario was played with one fewer player as one farmer had to leave for unexpected personal reasons. Participants were assigned a role corresponding to their role in real life. Table 2 introduces participants’ role in the game, their profile/farming system in real life and their “type” as determined during the ethnographic fieldwork (inclination towards science, politics and/or environmental conservation). We documented players’ behavior and equipped players with microphones to record their narrative during the two game sessions and the debriefing.

Players ID	Role in the game	Role and farming system in real life

#1	President of left syndicate and crop farmer	President of syndicate and crop farmer
#2*	Mixed farmer	Mixed farmer
#3	Mixed farmer	Mixed farmer
#4	Mixed farmer	Mixed farmer
#5	Mixed farmer	Mixed farmer
#6	Mixed farmer	Mixed farmer
#7	President of right syndicate and cattle farmer	President of syndicate and retired mixed-farmer
#8	Conservationist in charge of the reserve	Reserve assistant director

*Table 2: Participants' profile with their role in the game and their farming system/activity in real life *This player could only attend the game during which the classical scenario was played.*

2.4 Quantitative data analyses

To support the qualitative data collected during this study, we also performed quantitative data analyses on the participants' narrative of the two game sessions. We perform a content analysis (Carley and Palmquist, 1992), i.e. we examine the use of language of the farmers and of the nature conservationist in their daily-life as well as during a role-playing game session, and categorize words and phrases into key concepts, to elicit mental models. We chose this method over influence diagram, arguably the most common approach (Abel et al., 1998; Dray et al., 2006; Mathevet et al., 2011; Prager and Curfs, 2016), because of its non-intrusive nature, thereby allowing uninterrupted game session.

The analyses were conducted with IRAMUTEQ, a linguistic software based on R and Python (Ratinaud, 2009). Prior to performing analyses, the words of the transcript of the audio recording of the two game sessions were lemmatized (i.e. inflected forms of words were grouped together so that for example “had” and “has” were converted to “to have”). The text was sectioned into text segments based on a size criterion and punctuation (see Loubère and Ratinaud, 2014 for a full description). Only content words (nouns, verbs, adjectives and certain adverbs) were included. Function words, such as pronouns and articles, were not considered.

We performed a similarity analysis to identify potential semantic changes. A similarity analysis is a method based on graph theory that represents the connectivity between nods (or in our case, words) (Degenne and Vergès, 1973; Marchand and Ratinaud, 2012). The strength of the connectivity between two words was determined by the frequency of the co-occurrence of these words in text segments. The weakest links are removed from the graph to create a “maximum tree” (sensus Rosenstiehl, 1966), an acycle connected graph (Degenne and Vergès, 1973). The similarity analysis of IRAMUTEQ is based on the R-package *proxy* (Meyer and Buchta, 2019)[2].

[2] As IRAMUTEQ is based R, analyses ran in IRAMUTEQ can build on the large collection of functions and data sets developed freely by the R-community provided in the form of R-packages. In this case, we indirectly used the package *proxy* that computed the similarity matrix.

3. RESULTS

We first present the behavior of the players while playing the classical scenario (section 3.1.1), and the alternative scenario (section 3.1.2). We then present the results of the semantic analysis in section 3.2. From the narrative of the farmers during the ethnographic fieldwork and during the games, we identified three critical notions: management, birds and the commons (see section 3.2.1). We further detected a shift towards a common semantic amongst the players between the first and the second game sessions (see section 3.2.2). We also found that the interactions between the players increased during the second game session (see section 3.2.3).

3.1 Behaviours in the game

3.1.1 Classical scenario

All players contracted the action-oriented AES during the classical scenario session. At the end of the game, before the financial retribution from the action-oriented AES, three players made a loss, and four made a profit – among those four, three started the game with more crop fields than the others. They confirmed that their return in the game was equivalent to the ones they face in real life. After receiving the income from the AES, all players had positive return. Players commented that the income from AES was not perceived as a compensation for ecological services but as a meat production support. They considered it a salary that helps them to cope with financial difficulties.

During fieldwork as well as in the game session, farmers stated that they were increasingly driven to think in strict economic terms in real life; reducing costs, spending less time with animals, using second-hand equipment, and rarely meeting with colleagues. They deplored it and specified that one third of the time was allocated to the crop while it provides more than two third of the profit. Many farmers wished they could have more cropland. They regretted not to have ploughed their pasture before the ban was enforced. Some farmers argued about the necessity to fertilize and to mow early in the year in order to get better economic performance.

3.1.2 Alternative scenario

During the alternative scenario session, players could chose to implement “free-form AES” or “bonus AES”. After a short discussion, farmers agreed to implement a “free-form AES”, and created two groups of three (three being the minimum group size requirement). They all concurred that the current AES constraints induced an economic loss and an economic uncertainty due to payment delay and risk of reimbursement in case of contract statement violation. Therefore, the farmers preferred to start from scratch rather than the “bonus AES”.

In this form, each farmer received a payment depending on the collective performance of his group, and risked receiving no reward for his effort if the strategy was unsuccessful. Very interestingly, to mitigate the risk for the players with fewer crop fields, the players with the most crop field offered to financially support the former in case of AES failure. It is the collective insurance that brought farmers into a collective strategy. Despite the risk, they stated that the potential extra income was a strong motivation to work together. They also recognized that they were more willing to implement AES in the absence of constraints. For those skeptical about the ”free-form AES”, the risk sharing was preferable to an individual offset of current AES difficulties. The two groups of players, instead of collaborating to enhance the total number of birds, competed with each other. They elaborated their spatial strategical management at the level of the “water association” (water basin) and not at the whole landscape level. Players of one group tended to destroy favorable bird habitat in the other group; farmers with plots in both water associations allocated most of their cattle in tiles of the other group to maintain their production level, thereby destroying nests of the other group.

Despite the competition, the economic performances at the end of the alternative scenario session differed drastically from the classical scenario. Before AES income, all farmers ended with positive return. Their collective strategy generated more income compared to the individualist strategy from the classical scenario session (cf. Table 1).

However, the farmers acknowledge that such a mechanism is unlikely to be implemented in reality. They recognized their coordination limits - coordination being understood as "working towards the same objectives but in isolation" (Prager, 2015). They stand that a collective insurance fund is impossible on a water association level. They expressed regret regarding the first AES which were implemented twenty years ago, which was considered more flexible. The game helped them realize the consequences of their actions and the importance of the interaction, which might be a first step to the elaboration of a collective AES that could be applied in reality.

3.2 Semantic

3.2.1 Participants semantic across three critical notions: management, birds and the commons

The participants' narratives during the ethnographic fieldwork highlighted their respective semantic fields and the game was insightful to foster reciprocal influences and narratives changes. Changes in narratives between the classical and alternative scenarios are reflected in the word connectivity graph (Figure 4).

We identified three domains of semantic change related to three critical notions: management, bird, and commons. We focused on farmers semantic as they embodied the main actors of the AES implementation. The denomination 'farmers' refers here to the mixed farmers (not to the crop farmer, i.e. player #1).

3.2.1.1 Critical notion 1: Management

During the game session, farmers had very little use of the verb “gérer” (‘to manage’). They used the verb “produire” (‘to produce’) to refer to meat production. Farmers did not speak about complexity, nor did they replace complexity by another word or expression. For farmers, their production system remained complicated, not complex, “we are tired of hearing that we belong to a complex system”. They thus handled a production system with its inner complications. Farmers had an intensive use of the words related to production (“do we produce or do we provide a service?”, “I don’t raise cattle for tourists”). In comparison, the nature conservationists used the French verb ‘gérer’ and talked about habitat maintenance during the field interviews.

We recorded many expressions related to the economic uncertainty (“how much income?”, “does it pay”) stemming from the AES implementation in the game. In the course of the session with the classical scenario, the farmers’ expressed concerns about the structure of the public policy, and not about its ecological impact; “will the funding be limited?”, “will the eligibility criteria be flexible enough?”, “when will the funding be provided?”. In the alternative scenario where the collective result-based with no more constraints (“free-form AES”) was proposed, all the farmers had similar narratives; “no more direct constraints”, even though some farmers had difficulties to think in non-constraint terms. Indeed, we recorded many sentences such as “no, you forgot, there is no more constraints”. The implementation of this “free-form AES” has progressively transformed constraint-driven operations to more bird dynamics concerns. Before the new AES implementation in the alternative scenario session, the uncertainty was almost entirely articulated around the public policy and not the environment consequences of their actions while during the collective result-based AES implementation, questions focused on birds and the environment.

3.2.1.2 Critical notion 2: Bird

During the ethnographic fieldwork, we observed that farmers had some knowledge on birds' season of arrival and feeding habits, but not so much on habitat requirement for breeding in terms of grass composition and size. They use the French term "piaf" (quite pejorative word, meaning a bunch of bird or one bird). These findings were confirmed by the players' discourses during the game.

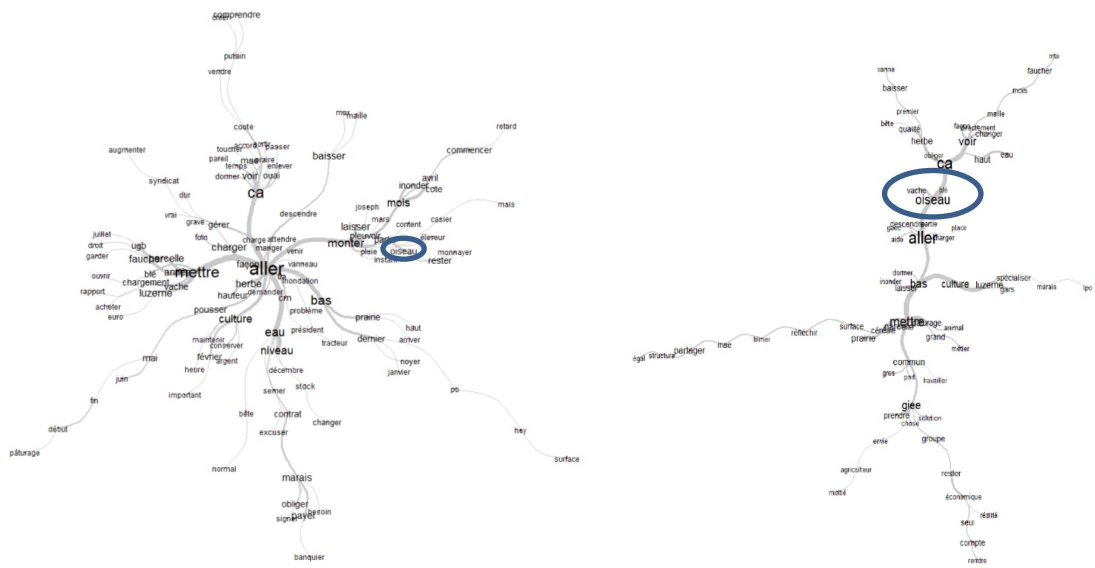

Figure 4: The two word connectivity graphs from the similarity analysis, with the narratives from the classical scenario on the left and from the alternative scenario on the right. Words size is proportional to their frequency, and branches thickness is proportional to the strength of the connection between two words. The blue circles are centered around the word "oiseaux" ("bird"), which in the alternative scenario is closed to the words "vache", "ble" and "oiseau", respectively "cow", "wheat" and "bird".

During the classical scenario session, farmers spoke about "bestiole" and "piaf" (quite pejorative words for "animal" and "bird" respectively) rather than "oiseaux" literally translated by "birds". They did not mention the birds' conservation effort but for the "bestiole"/"piaf" presence's accountability, they did acknowledge a fauna presence. In the word connectivity graph of the classical scenario, the word "oiseaux" (bird), is anecdotal, and distantly located from the words “vache” (cow) and “blé” (wheat), while in the graph of the alternative scenario, it is predominant and closely associated to the words “vache” and “blé”.

In the meantime, farmers did not speak about habitats nor environments, rather “cultivated fields”, “grasslands plots”, “ridges” and “canals”. During the classical scenario session, the reference to “bestiole”/”piaf” contrasted with the nature conservationists who referred regularly to “species” and especially to “habitats”. However, during the alternative scenario session, no such word came out. The farmers and the nature conservationist spoke about “birds” and met in a common semantic field. Moreover, the notion of cattle and wheat came regularly with the notion of bird as depicted in the Figure 4, revealing a cause-consequence link. During the alternative scenario, farmers asked many questions to the nature conservationist regarding bird ecology.

The nature conservationist faced the problem of the operational ecological knowledge; the nature conservationist had to translate his own expertise in terms of production, “produce birds”. The nature conservationist made a translation during the alternative scenario session, answering in farmers’ words to farmers asking how to produce more birds in the game. He did so by explaining how the relationship between grass height and water level in the game can trigger birds’ presence on specific fields. The farmers and the nature conservationist have thus used a production semantic while speaking about birds avoiding any management narratives. In doing so, they linked the conservation’s narratives with the production semantic, involving a new conservation’s production discourse, “We are doing badly for the birds, we need to improve our business”.

3.2.1.3 Critical notion 3: Commons

During the ethnographic fieldwork, farmers’ narrative was rather oriented on individual concerns while avoiding the subject of the collective dimension in their socio-economic life. They stated acting in an individualist way with some mutual help when needed after unexpected gear problems or complicated maintenance. This contrasted with the semantic of the nature conservationist who talked about collective effort and need for cooperation in order to provide a good ecological state at a regional scale. The individualistic semantic of the farmers was reflected in the game. During the classical scenario session, no collective semantic such as “together”, “common”, “with others”, etc. emerged. The word connectivity graph of this scenario is star-shaped with multiple branches centered on one word (Figure 3, left). This shape suggests an absence of a common semantic between the players and is consistent with a lack of collaboration, as described by the players during the debriefing session.

The farmers’ narratives corresponding to the collective dimension appeared only during the alternative scenario session. The shape of the corresponding graph (Figure 3 right) is more linear, with a large lateral branch and a second thinner one. This shape suggests that players adopted a collective semantic. It is also in this scenario that the words “to share” and “group” were mentioned. This pattern can be expected to emerge from the implementation of collaborative strategies. Indeed, during the debriefing, players explained that they worked in groups to be able to meet bird targets to receive compensation.

3.2.2 The semantic shift

In the second session, the farmers changed their semantic using a bird semantic while thinking more broadly in terms of animal production. Moreover, they acted with a more collective perspective, from individual dynamics to hybrid ones with collective and individual dynamics. Conversely, the nature conservationist adapted his semantic from “species” to “bird”, from “habitat” to “birds” and “grassland” and “cattle”, and from collective to collective and individual. The cognitive shift is schematized in Figure 5. The central cell, where the farmers and the nature conservationist met at the end of the game sessions, reflects the semantic convergence. The nature conservationist adopted a ‘bird production’ metaphor to meet with the farmers' original semantic focused on meat production. Note that the semantic of both parties do not overlap fully as representation divergences remained. This cell can be characterized as a collective and multi-issues space of discussion. It is a condition for the new AES success since stakeholders brainstormed all together in new modalities. It provided an opportunity to exchange about divergence and agreement while converging to decision and collective action.

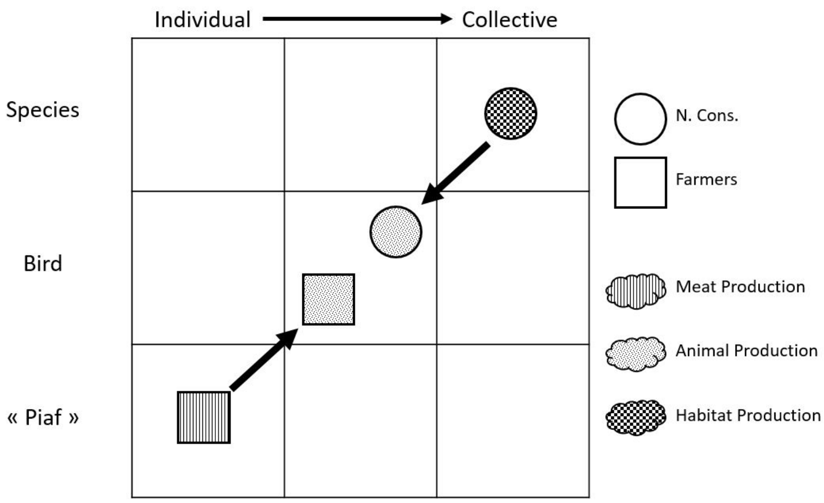

Figure 5: The graph qualifies the cognitive state in the classical scenario for farmers (in square) and the nature conservationist (in circle), as well as the common domain in the center of the table from the alternative scenario. The gradient between individual and collective induce a twofold semantic with both individual and collective references.

3.2.3 Interactions amongst participants through semantic analysis

The ethnographic fieldwork revealed that in reality, each participant interacts with at most three other participants, and three participants do not regularly interact with the others (Figure 6). The farmers all work on their own and believe they are too different one from another to be able to work effectively in cooperation. Few participants are politically active or involved in a union movement and few have responsibilities in local networks. On a social dimension perspective, farmers do not interact very often; they meet during water management meetings or technical training groups and have almost no discussion opportunities. They stated that collective action is limited because of divergent personal projects and views. Moreover, sharing farm equipment is made virtually impossible because of the very narrow mowing period allowed by AES.

From the transcript of the recording of the game sessions, we could determine the interactions between players and their intensity (low/high) on the topics of birds and crop/grassland. During the game, many more interactions took place than in reality. More interactions happened during the alternative scenario session than during the classical scenario session, and interactions were more intense on the topic of crop/grassland than on birds.

During the classical scenario session, farmers interacted mostly with each other (#3-6) and the water association presidents (#1 and #7). One of the water association presidents (#1) had to make the link between farmers and the nature conservationist (#8) to discuss crop and pasture management. On the contrary, during the alternative scenario session, both water association presidents (#1 and #7) had almost nothing to do since the farmers interacted directly with the nature conservationist. They were no longer acting as intermediaries nor interpreters.

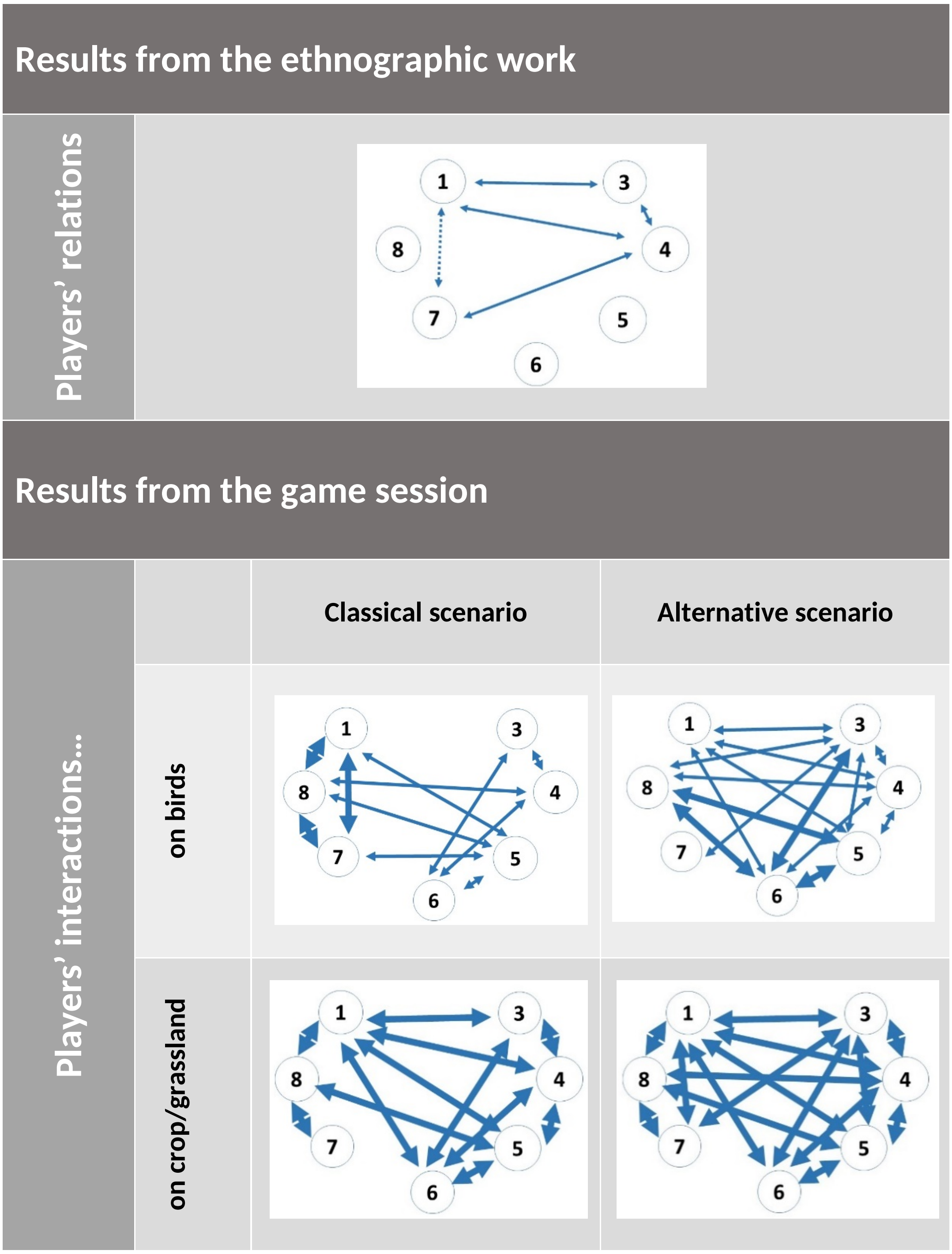

Figure 6: The different types of interactions are depicted in the different sub figures. The top row illustrates the relationship before the game (extracted from the ethnographic fieldwork), the dotted arrow qualify a rather conflictual relationship between the two water associations' presidents (#1 and #7) while the other arrows show good relationships. The other sub figures illustrate the levels of interactions during the game session. Each arrow's width corresponds to the discussion intensity about the subject related by each line (birds or crop/grassland). Due to unforeseen personal reasons, players #2 had to quit the game during the alternative scenario session and is therefore not positioned in the scheme.

4. DISCUSSION AND CONCLUSION

Our work explores public policies to conciliate agricultural production, biodiversity conservation and water management in wet grasslands, with the case study of the Marais Poitevin wetland located in France. We examine the current individual action-based policy as well as collective result-based alternatives. We use a two-fold methodology combining an ethnographic fieldwork and a role-playing game experiment. In addition, in both approaches we lead a semantic analysis in order to complete our work with a language-based interpretation eliciting subjacent mental models.

The ethnographic fieldwork allows us to study the actor's relationships, which is useful in understanding collective policies. It is also helpful to create trusting relationships and legitimacy between the scientific team and farmers to allow involvement in the role-playing game.

In the role-playing game, players explore three public policy tools. The first one is the existing policy, namely an action-based individual AES. Two alternatives are offered to the players, namely a result-based but action-constrained collective AES and a free-form result-based collective AES. Only the free-form AES was chosen by the players and tested during the game session. This choice is a result *per se*, which we discuss below.

Our work contributes to the literature as it provides a rare example of a collective result-based AES experiment while this form of AES is less common than action-based ones and is promising (Le Coent et al. 2014, Schwarz et al. 2008). This innovative form of AES also presents the interest of being a bottom-up approach rather than top-down as farmers choose themselves which actions to implement to reach a given objective. Another contribution lies in the fact that the role-playing game has an educational function; it helps actors understand the consequences of their actions and the benefits of their interaction. It thus represents a first step in the implementation of collective result-based AES.

Our main results are the following.

First, farmers all chose the free-form AES in the game when presented with the opportunity to select either a free-form or a constrained AES. It is a strong result given that there is a double uncertainty for farmers when choosing the free-form AES. The first source of uncertainty is due to the collective characteristic of the AES making the payment depend on a collective result and thus on the behavior of the other farmers, contrarily to an individual AES. The second uncertainty comes from the result-based form of the AES making the payment less predictable as the result (bird abundance) depends on random factors that are independent from farmers' efforts. Despite these uncertainties, farmers unanimously chose this free-form and built a collective insurance - some farmers offered to support other farmers in case of AES failure - to mitigate these risks. Farmers prefer to quit the constrained system (late mowing date and reduced trampling) to favor a blank page strategy, working together on a new set of constraints. Such AES modalities reveal farmers' need for flexibility and recognition as pointed by Emery and Franks (2012).

Second, we observed that in the free-form AES, competition appeared between the two groups of collective AES with some farmers trying to sabotage the other group's conservation effort. This questions whether this adverse effect of free-form AES could appear in real-world implementations. The problems induced by the 'bird production' implementation and the risk of 'a race for bird' with detrimental effects thus call for the necessity to address the result of the collective result oriented AES through a participatory process (Lardon et al., 2010) and a landscape approach (Sayer et al., 2013) where system boundaries are clearly defined. In our case, the two groups implemented a spatial planning at the scale of the water association, not the whole landscape.

Third, the economic performances before the AES payment were improved in the collective result-based AES compared to the individual action–based one. This finding supports the implementation of collaborative result-based over individual action–based AES. The literature tends to support the cost effectiveness of the result-based approach (Reed et al., 2014), as well as its ecological benefits (Musters et al., 2001). However, as modelled by Groeneveld et al. (2019), adverse effects can also arise under the collective scenario, even if the economic incentives seem higher. How farmers weight biodiversity plays a key role in ensuring participation in collective scheme and long-term commitment.

Last, the semantic analysis demonstrated the existence of three critical topics in the language used by the actors: management, birds and the commons. Moreover, we noted a shift towards a common semantic and towards increased interactions between the first and second game session. In other words, the level of interaction between the farmers but also between the farmers and the nature conservationist were higher when they played the alternative scenario. As in this scenario farmers have to collaborate, it is trivial that they interact more with each other. Likewise, as the reception of the financial retribution is condition upon biodiversity outcome, it is not surprising that they exchange more with the bird conservationist to ask him about the conditions favorable to biodiversity. The implementation of a collaborative approach to AES could likely increases social interactions between the stakeholders, something that the cattle farmers and the nature conservationist stated during the ethnographic fieldwork they would welcome. The increase in social interaction can be beneficial beyond the simple exchange of information. Under a collective dynamic, farmers are in a better psychosocial condition to perform AES's measures (van Dijk et al., 2016).

Our work presents some limits and several of our results can be discussed. The fact that participants achieve a common semantic and increased interactions in the second game session compared to the first one may be a normal evolution with time and players' experience, rather than due to the collective form of the policy. Other game experiments should be implemented to elucidate this point. Also, we compare two AES for which two parameters differ: the individual vs collective form and the action vs result-based form. It would have been interesting to change one parameter at a time and test a collective action–based AES and an individual result-based AES as well[3]. This opens scope for further research.

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[3] However, relevant result-based AES are generally collective as the interesting results for biodiversity conservation usually call for the simultaneous effort of several actors. That is the reason why we directly tested a collective result-based approach.

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