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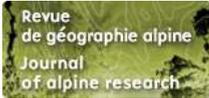
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Trajectoires de vulnérabilité des territoires de montagne face aux changements globaux

Pathways of Adaptation to Climate Change: Analysis and Transformation of the Governance System of the Ardennes Mountain Area

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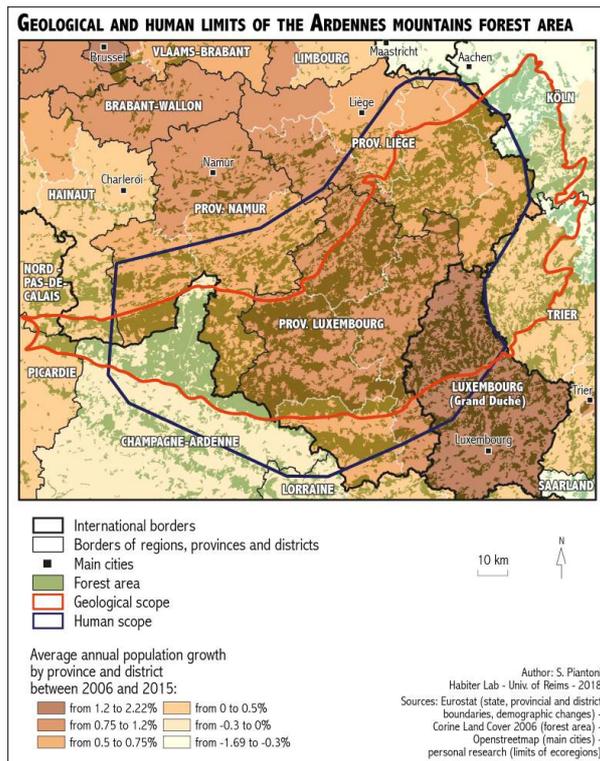
Jon Marco Church

Introduction

- 1 In-between France, Belgium, Luxembourg, and Germany, the Ardennes are a mountain forest in the heart of Europe. Even if it is a small mountain not covered by the French mountain law, the territory is certainly mountainous. It is characterized by issues shared with other mountain areas such as a fragile ecosystem, an important forest cover, mountain agriculture, a three-dimensional rurality, changing demographics, and significant cultural landscapes. This territory has significant water resources, as well as some exposure to natural hazards and vulnerability to climate change. In addition, the Ardennes are far from the urban centers, and crossed by transport and tourism axes and flows, as well as by borders. These characteristics are not unique to the Ardennes but are shared by many other mountain areas in Europe (Debarbieux, Price, & Balsiger, 2013, Debarbieux & Rudaz, 2010).
- 2 The Ardennes are in a globally temperate climate zone with many microclimates between forests and prairies. As in other comparable areas, climate change is currently mainly reflected by an increase in the frequency of intense weather events, elevation of vegetation belts, changes in habitats and biodiversity, as well as alteration of hydrological regimes, and intensification of hydrogeological processes (Golobic, 2006). Climatic projections over the next hundred years in the Ardennes suggest an increase of 2 to 3° C in the average annual temperature in the region. The precipitation regime would also be

strongly modified (Terlinden, 2011). It is fundamental for the Ardennes to be able to anticipate these changes and their impacts, given the likely impact by 2050 on a particularly sensitive vegetation cover and given investments in the agro-forestry sector that are particularly important on the French side, where returns for investment often exceed 30-40 years.

Figure 1: The geological and human scope of the Ardennes and the growth of the population (2006-2015)



Author: Sébastien Piantoni, HABITER research team, University of Reims Champagne-Ardenne

- 3 However, existing scientific approaches are not yet able to accurately anticipate the impacts of climate change, particularly at the territorial level (IPCC, 2014). One reason is that many approaches rely mainly on biogeophysical dynamics, neglecting the social dimension (Folke, 2007; Liu et al., 2007; Redman, Grove, & Kuby, 2004).¹ This is particularly problematic for the Ardennes, where a relatively uniform biogeomorphology corresponds to a particularly contrasting demographic situation, with a significant drop on the Franco-German side and marked growth in the Belgian-Luxembourgish part. The use of approaches that rely exclusively on biogeophysical dynamics may underestimate, for example, the differential impact of climate change on both sides of borders.
- 4 From this perspective, governance plays a fundamental role (Matson, Clark, & Andersson, 2016, pp. 83-104). It is especially through governance systems that knowledge about the impacts of climate change is co-produced by various actors, including scientists, and circulates; it is through these systems that collective choices can be made and contribute or not to the adaptation of areas to climate change. These choices depend on the relations between the actors and can give rise to policies and measures aimed at anticipating and possibly counteracting the effects of climate change. It is therefore important to study the governance system of the Ardennes and see which of its features are conducive to

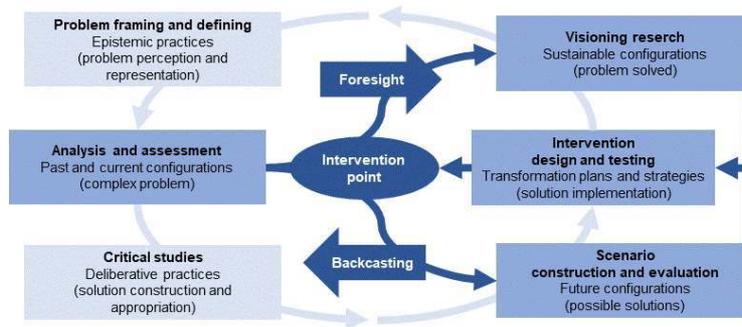
facilitating adaptation to climate change in this area. We therefore suggest that these characteristics of the Ardennes governance can act as a driver or obstacle in relation to greater adaptability. To answer this question, many approaches can be employed.

- 5 First, this article looks at the identification of pathways of adaptation to climate change. We therefore employ transformational sustainability research methods (Wiek & Lang, 2016) through an original methodological framework derived from this approach. Illustrated below, this framework was developed to integrate the different methods most commonly used in transformational research. One of these methods is the general framework for the analysis of the sustainability of socio-ecological systems (SES) developed by Elinor Ostrom. This approach was developed especially for the study of the commons (Ostrom, Burger, Field, Norgaard, & Policansky, 1999) and integrates not only the interactions of biogeophysical elements, such as units and resource systems, and ecosystems, but also social factors, such as actors and governance systems, as well as the social, economic and political context, to analyze the results in terms of impact on the SES (Ostrom, 2009; Ostrom, Janssen, & Anderies, 2007). Many case studies have been produced in recent years based on this framework. In this article, we use a version of the Ostrom framework (Church, 2016; 2019), adapted specifically to large socio-ecological systems such as the Ardennes. Within this text, we will consider as synonyms the two concepts of “socio-ecological system” and “environmental region” (Church, 2015).

Towards transformational research for the Ardennes

- 6 Climate change is expected to have impacts far beyond previously observed variability. Adaptation to climate change requires profound transformations. Several approaches propose theoretical and methodological frameworks to consider these transformations. In this paper, we use a framework that was developed and adapted from the methodological framework TRANSFORM, proposed by Wiek and Lang (2016, pp. 31-41). We are mobilizing here the active concept of transformation, which makes it possible to highlight the role of different actors on the territories and which one also finds in the last reports of the IPCC (2014), rather than the more passive notion of transition.

Figure 2: Framework for analyzing the transformations of a socio-ecological system



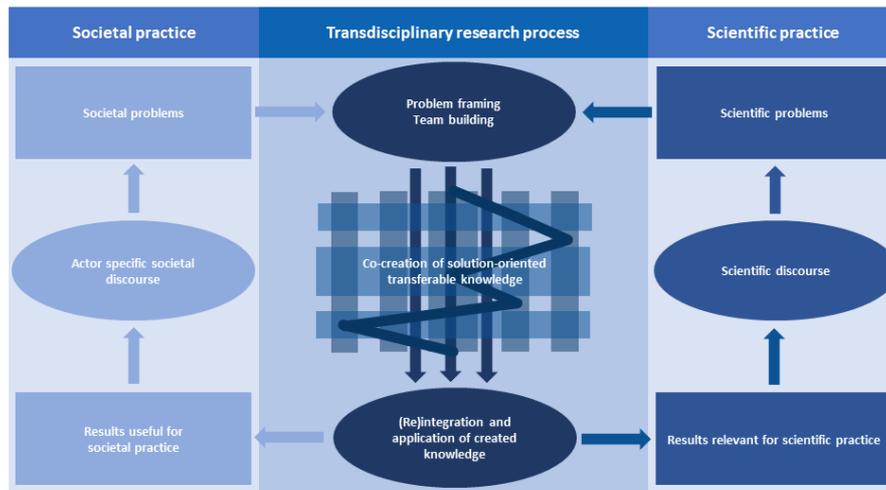
Author: redesigned and adapted by the author based on Wiek and Lang (2016, p. 38)

- 7 This framework was developed to integrate the different methods most commonly used in transformational research. With respect to a situation and a given point of intervention, this framework combines diagnostic analysis, prospective analysis, retrospective analysis, interventionist approaches, as well as reflexive and critical approaches, which are missing in the original framework. For example, to help solve a problem of sustainability of an SES and to propose solutions, we are interested first of all in the diagnostic phase, which is fundamental to frame the problem and to identify the driving forces; afterwards we look at prospection into the future, i.e. in how the problem could be solved; then, we engage in retrospective work, to find out what are the possible solutions; finally, we propose a reflexive and critical phase at each step. Each component of this framework, which corresponds to the rectangles in the figure above, indicates three elements: the type of action (in bold: analysis, study, scenario development, implementation, framing, criticizing); the targets of actions (without format: configurations, plans, practices); the drivers of actions (inside brackets: problems, solutions). Each element therefore answers a specific question: what action? on what? why?
- 8 Regarding our point of intervention, which may be the will of certain actors to transform the Ardennes governance system, the starting point in a transformational research approach is the analysis and diagnosis of the area. This analysis aims to identify current and past configurations. This is a fundamental step, as SES often present complex problems with many variables that interact with each other in a non-linear, adaptive, and sometimes unexpected ways. In our case, this is the diagnosis of the system of governance that we will present below. On this basis, the next phase consists of two parallel steps of prospective and retrospective analysis: on the one hand, the prospective studies establish the sustainable configurations in which the problem would be solved in the long term; on

the other hand, the scenarios indicate the future configurations of the possible solutions to the problem in the short, medium and long term. Scenarios are always multiple and normally present a trend scenario, an optimistic scenario, a pessimistic scenario and one or two intermediate scenarios, if needed (Lane & Montgomery, 2014; O'Neill et al., 2017; Van Vuuren et al. 2014). They make it possible to study the feasibility of the various options and to increase the relevance of the actions envisaged, but they are also based on many hypotheses, which rely on the limited knowledge and the biases of those who realize them and who can be shared at different degrees (van Ruijven et al., 2014). Their construction and evaluation are therefore particularly important.

- 9 These two parallel approaches then contribute to the design and experimentation of interventions. In the case of the Ardennes, an example of intervention would be the adoption of an international convention for the protection and sustainable development of the Ardennes on the model of the Alpine Convention and of the Carpathian Convention. This usually translates into intervention plans and strategies that may include pilot projects on the ground to prepare for the implementation of interventions. This is the stage prior to the actual intervention by the actors, which can certainly be inspired by transformational research, but which will follow a practical logic that does not only depend on scientific knowledge, but also material conditions of realization and other types of knowledge. This implementation phase, along with all the other steps identified so far, therefore requires framing and defining the issues that concern the epistemic practices of the actors concerned, because their perception and representation of the problem plays a fundamental role in the construction of the proposed solutions, as we have seen in the case of scenarios. Any phase also requires critical studies of deliberative practices, as the construction and ownership of solutions also depend on the actors and their power relations (Epstein, Bennett, Gruby, Acton, & Nenadovic, 2014).
- 10 In this respect, one of the limitations of the proposed approach is that it focuses solely on the research needed to generate transformations and does not distinguish the actors of this transformational research. A framework for identifying boundary work (Clark et al., 2011) between scientists and practitioners from a transformational research perspective is the conceptual model for a transdisciplinary research process below, which was developed by Lang et al. (2012). This framework is not limited to studying the interaction between several scientific disciplines. It tries to combine societal practices and scientific practices with a view to integrating scientific knowledge with knowledge from practice. In a transformational approach, the co-production of knowledge is important for the appropriation of solutions by the actors from the perspective of implementation and therefore of intervention.

Figure 3: Conceptual model of a transdisciplinary research process



Author: redesigned by the author on the basis of Lang (2012, p.28)

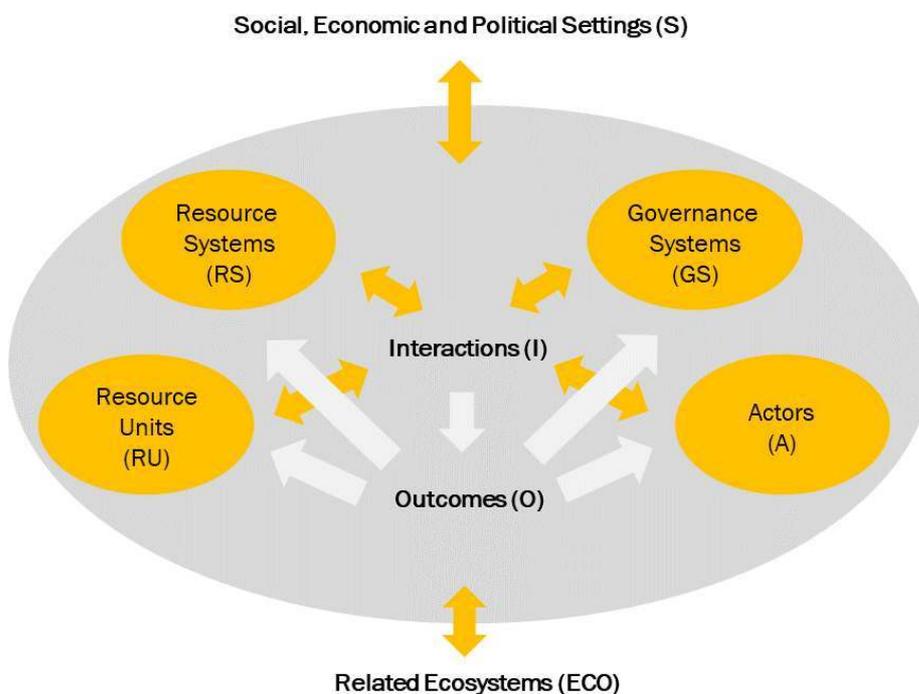
- 11 Societal problems and scientific problems are the starting point of a transdisciplinary research process. They are not necessarily identical. The framing of a problem and the constitution of the team that will work to identify solutions is therefore very important, because the sharing of the problem and the legitimacy of both the scientific and the societal team are fundamental to the process of co-production of transposable and problem-oriented knowledge. This is a non-linear process that aims at the ownership and implementation of co-produced knowledge. Secondly, these results can be, on the one hand, used in societal practices and, on the other, contribute to scientific practices. They fuel both societal and scientific discourses that will then contribute to the definition of new societal and scientific problems. This iterative process brings us back to the starting point with new challenges. This transdisciplinary research contributes to what some authors describe as adaptive governance (Gupta et al., 2010; Karpouzoglou, Dewulf, & Clark, 2016; Webster, 2009) and is a key variable in any SES governance system.

Ostrom's general framework

- 12 To illustrate our remarks, we present here a case study on the system of governance of the Ardennes mountain area. In this article, we limit ourselves to sketching a diagnostic analysis. A much larger transdisciplinary research program on the Ardennes would be needed to contribute to a process of transformational research in this area and contribute to the sustainability of this mountain forest in the heart of Europe. To do this, we will mobilize the general framework to analyze the sustainability of SES that was proposed by Ostrom (2009; 2007). We chose this framework because it is probably best suited to characterize interactions between society and the environment (Binder, Hinkel, Bots, & Pahl-Wostl, 2013). According to Claudia Binder and her coauthors, this is the only

analytical framework that takes into consideration social and ecological systems in almost equal depth and that can produce more or less specific analyses through the differentiation of several levels. Ostrom's general framework first relates the studied SES, for example the Ardennes mountain area, to its social, economic, and political context, as well as to associated ecosystems, like the climate system. Then, the framework identifies four subsystems: resource systems, resource units, governance systems, and actors. The Ostrom's general framework therefore invites us to study the interactions among these subsystems and their results in terms of, for example, sustainability. Finally, it also incorporates the feedback loops between these results and the components of the SES, as highlighted in the diagram below.

Figure 4: The structure of the general framework for analyzing the sustainability of socio-ecological systems



Source: Ostrom 2009, p. 419, (redrawn and translated).

- 13 Ostrom then proposes several second-level variables for each subsystem (2009, 420). These variables were identified based on many case studies conducted over three decades. These are cases of mostly small SES, characterized by the presence of a single principal resource under common ownership. This framework therefore needs to be adapted for use in relation to large systems (Cox, 2014; Fleischman et al., 2014) and other property regimes. For these reasons, for several years, I have been developing a list of third and fourth level variables to better characterize the governance of large SES, like the Ardennes mountain area (Church, 2016). These variables were identified based on six representative case studies of terrestrial, marine and freshwater ecosystems around the world. This adapted framework was used to produce the analysis below.
- 14 The sources of information for the analysis of the Ardennes SES and in particular its governance system are multiple. First, I supervised in 2013 a workshop of the second year

of the master in sustainable urban and environmental planning of the University of Reims Champagne-Ardenne on ecological connectivity together with the Ardennes Regional Natural Park, which was followed by the four papers on the Ardennes environmental region by students of the same class.² I then organized in 2014 an international seminar in Sedan on the sharing of experiences between cross-border mountain areas, in particular the Alps and the Ardennes, in collaboration with the University of Reims, the Ardennes Regional Natural Park and the Italian Presidency of the Alpine Convention. In 2015, I was able to discuss with many actors, like the ex-president of the former Champagne-Ardenne Region, as well as the president, director and staff of the Ardennes Regional Natural Park and the Director of the Viroin-Hermeton Natural Park in Wallonia; I also supervised a master dissertation on the governance of the Walloon forest in the Ardennes.³ The same year, I also participated in a symposium organized by Virginie Joanne-Fabre as part of the ARDIHES project, which was funded by the CNRS under the PEPS program and was entitled “The Ardennes mountain area facing climate change: mathematical modeling of a socio-ecological system”. Lastly, in 2016, in collaboration with the SENSE network (Research School for Socio-Economic and Natural Sciences of the Environment) in the Netherlands, I organized a fieldtrip in the Ardennes as part of the doctoral level GOSES Summer School on the governance of SES. This workshop brought together practitioners and scientists with the aim of co-producing knowledge on the Ardennes governance system and providing solutions. This workshop used the Ostrom framework to co-produce some key elements of the analysis below.

The socio-economic and ecological challenges of the Ardennes mountain area

- 15 The Ardennes are a mountain forest shared by four countries: France, Belgium, Luxembourg, and Germany. No large city is within its perimeter. Four cities of a certain size are however at its doors: Charleville-Mezieres, Liege, Luxembourg, and Cologne. Its perimeter changes according to the elements that are taken into consideration, as illustrated in the map above: forest, geology or human factor. The concentricity of these different definitions shows the coherence of the SES and its close link with the mountain forest.
- 16 The Ardennes face many ecological challenges. As far as the climate is concerned, they are in a globally temperate climate zone with many microclimates between forests and prairies. According to the climate projections, the average annual temperature over the next hundred years should increase by 2 to 3 °C throughout the Ardennes. An increase in the frequency of intense meteorological phenomena, as well as an alteration of the hydrological regimes and an intensification of the hydrogeological processes are thus foreseen. A major change in the precipitation regime is also expected (Terlinden, 2011). This is particularly important compared to the Meuse river basin, which crosses the Ardennes in the Givet area in French territory before moving to Belgium and then to the Netherlands. The Ardennes are therefore a bottleneck for this transboundary river, which has resulted in several floods. A system of dams was put in place to reduce the risk of flooding and is currently being upgraded and automated on the French side. This is done not only because of the obsolescence of existing facilities and therefore their inability to cope with climate change, but also to reduce the risk of disputes over these transboundary waters. In addition, since 1994, the Meuse International Commission has

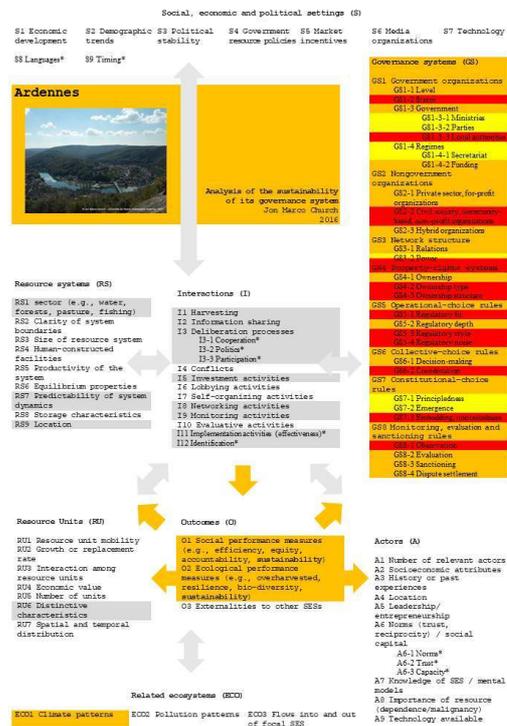
been ensuring the protection and integrated management of these water resources that are shared between several countries. However, it is important to note that part of the Ardennes on the Luxemburgish and German side is outside of the Meuse river basin and that the basin goes well beyond the Ardennes mountain range. In relation to flora and fauna, climate projections are reflected in elevation of vegetation belts and changes in habitats and biodiversity (Golobic, 2006). It is a particularly vulnerable ecosystem, where the impact of climate change should be already visible by 2050.

- 17 The Ardennes face many socio-economic challenges. It is likely that climate change will have a significant impact, for example on forest activity in Belgium, since the Ardennes forest is the one with the highest afforestation rate in Wallonia (Gameren, 2014) and returns for investments in the forestry sector often exceed thirty or forty years. According to a study by the Walloon Region (2011), it seems, however, that most Walloon forestry actors are already taking measures to cope with the effects of climate change, even if this is done in a manner that is not always conscious. The tourism sector is also important. The Ardennes are sometimes considered as the “French Riviera” for Belgians. The impacts of climate change on the tourism sector, developed on the Belgian side, are difficult to assess. The various impacts would take place on the background of a particularly contrasting demographic situation, with a significant drop on the Franco-German side and a marked growth in the Belgian-Luxemburgish part driven by the dynamism of the Grand Duchy’s economy. Figure 1 shows a strong border effect between the four countries.

Diagnostic elements of the governance system of the Ardennes mountain area

- 18 Based on field visits and an assessment of the Ardennes governance system (Church, 2016), we have therefore identified in a participatory way, in the framework of the abovementioned GOSES summer school on the governance of SES⁴, the variables of the other subsystems that correspond to the ecological, economic, and social challenges of the Ardennes mountain area in relation to climate change. These evaluations were the subject of an in-depth discussion and take into account the considerations of a variety of types of players in the governance of the Ardennes who participated in this exercise. In a mental experiment, we then reflected collectively on the interaction between these variables and those of the governance system. This made it possible to establish whether features of the governance system of our case study would have had a positive, neutral or negative impact on the sustainable development of the SES by 2050, defined as “capacity to improve human well-being while preserving the systems that sustain life on the planet in the long run” (Matson et al., 2016). It also includes adaptation to climate change.

Figure 5: Diagnostic analysis of the Ardennes socio-ecological system



Source: author's original production (2016).

- 19 We synthetically illustrated these impacts of climate change in a large graph, redrawn and reproduced in Figure 5. The orange elements correspond to the three fundamental components of the analysis: climate dynamics, governance system, and results in terms of sustainable development. The gray elements correspond to the variables of the other subsystems, where the context appears have a greater impact and which seem to play an important role in the interaction with the governance system and the climate dynamics from the perspective of sustainability. So, we focused on the variables that we think are most relevant. In relation to the governance system, we highlighted in yellow the variables that will have a likely positive impact on the sustainable development of the Ardennes by 2050 in the context of climate change and which could constitute accelerators of sustainability. On the contrary, some variables are in red because we think they may have a negative impact.
- 20 This analysis of the governance system of the Ardennes mountain region and its adaptation to climate change identifies the limits of the current system. The absence of an SES observatory of the Ardennes as a whole, the lack of structured intersectoral dialogue, and the limited capability of local authorities and civil society, among others, represent, at the end of this collective work, obstacles to climate change adaptation on the entire territory of the Ardennes. However, in the process of co-production, we have also identified positive elements, including the partial political alignment that is currently observed and the potential of tourism and of the “Marque Ardenne”, which is a territorial marketing project of many actors of the French, Belgian and Luxembourg tourism sector that have joined forces since 2014 within the framework of the European Economic Interest Grouping (EEIG) “Destination Ardenne”. The latter could represent the

core of a governance system that integrates other sectors, such as water resources, but also the forestry and residential sectors.

Conclusion

- 21 As part of a transformational research process, these diagnostic elements can provide a starting point for prospective and retrospective analyses that may consider possible solutions and their feasibility. These elements are however far from being able to represent elements of strategy to contribute to the sustainable development of this territory. Only after the completion of prospective and retrospective analyses we can implement transformation strategies, while considering the limits of deliberative and epistemic practices in place and to come. At the same time, these processes are also transdisciplinary research processes, which lead to the co-production of knowledge by scientific and societal actors. In this article, we suggest that this type of transformational and transdisciplinary research process can contribute to greater adaptation to climate change.

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NOTES

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ABSTRACTS

The Ardennes are a mountain forest area in the heart of Europe. It is fundamental for this mountain area to be able to anticipate climate change and its expected impacts. In this article, we are particularly interested in the Ardennes governance system. We first use transformational sustainability research methods through a methodological framework that combines different methods. In this context, we proceed with a diagnostic analysis of the sustainability of the Ardennes governance system. This analysis was developed from a version of the general framework for the analysis of the sustainability of socio-ecological systems developed by Ostrom. It was adapted to a large system and applied as part of a participatory research process. This identified three main vulnerabilities: the absence of an observatory of the socio-ecological system as a whole, the lack of a structured intersectoral dialogue, and the limited capacity to act of local authorities and civil society. We therefore suggest conducting prospective and retrospective analyses to identify adaptation paths of the governance system in relation to climate change. This should make it possible to design and experiment interventions to transform the governance of this large socio-ecological system towards greater sustainability.

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Keywords: Ardennes, socio-ecological system, sustainability, governance, transformational research

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