Data Ecosystems and Disaster Risk Reduction in Cross-border Regions: Visioning from 2020 Roya Valley Flood Disaster

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ABSTRACT

Knowledge on the practical support from data ecosystems to disaster risk reduction remains partial. More specifically, we misunderstand the drivers and challenges inherent to emergency data ecosystems development in cross-border regions. We also miss cases of data ecosystem building in those regions. This research addresses these gaps by abiding by the principles and guidelines of visioning, a prospective and collaborative research design. Based on qualitative interviewing and archive analysis of the case 2020 Roya Valley floods, this work provides a prospect of a segment of data ecosystem that involves an organizational field aiming at Disaster Risk Reduction (DRR) at the French-Italian border. Still in progress, this work provides a comprehensive narration of a fictious data ecosystem. The narration hints at the major benefits and challenges inherent to this potential data ecosystem. This work enriches our understanding of data ecosystems' features and benefits to cooperation between organizations involved in emergencies at borders (such as governments, civil protection agencies, volunteer-based organizations). In future development it will propose an agenda to support practitioners in the development good practices related to data ecosystems.

Keywords:

Data ecosystems, cross-border regions, organizational field, disaster risk reduction

INTRODUCTION

This research aims to better understand how a data ecosystem can help a cross-border organizational field reduce disaster risk. Nowadays, data ecosystems represent valuable tools to produce, share and integrate information between organizations involved in disaster management (either in humanitarian or emergency settings). Data ecosystems can be defined as a "*loose set(s) of interacting actors that directly or indirectly consume, produce, or provide data and other related resources (e.g., software, services, and infrastructure). Each actor performs one or more roles and is connected to other actors through relationships*" (Oliveira and al., 2018, p.604). As illustrated by the report from the Joint Research Center (JRC) of the European Commission, data ecosystems can help alleviate the damages and costs inherent to disasters. For instance, from the data exchanged within an ecosystem, organizations can generate and share more reliable alerts (Van den Homberg & Susha, 2018) The data-ecosystem can also federate organizations towards transparent data sharing through decentralized governance (Haak, Ubacht, Van den Homberg, Cunningham, & Van den Walle, 2018).

Cross-border regions, characterized by the existence of diverse frontiers and boundaries, are particularly vulnerable to natural disasters. Not only those regions are particularly exposed to natural and man-made hazards. In addition, organizations in charge of disaster risk reduction can face coordination and information integration issues. The literature suggests that data ecosystems can help cross-border organizational fields identify and share information on risks inherent to disasters. However, given multiple boundaries, data ecosystems also represent challenging socio-technical systems to settle, maintain and govern (Haak et al., 2018). Hence, a gap remains between, on the one hand, the expected benefits from data ecosystems to cross-border organizational fields, and the other hand, our actual knowledge on how a data ecosystem can practically benefit to the field. Given the foregoing, our research project covers the two following questions:

1. "*How can an organizational field located in a cross-border region rely on a data ecosystem to mitigate disaster risks?"*
2. "*What are the drivers and challenges inherent to the building of a data ecosystem within an emergency organizational field at a cross-border region?"*

We address these two research questions by leading a visioning research process in collaboration with a cross-border organizational field. This paper is also part of a wider pedagogical project that aims to train 8 master students to use scientific methods in a professional context. Visioning consists of collaboratively designing a preferable future within the society (Smith, Stirling, & Berkhout, 2005). More specifically, our research, still in progress, aims at elaborating a prospect of risk reduction regarding evacuation delays, in the context of a cross-border flash flood. Visioning is particularly relevant when technological opportunities exist but remain unbounded – such as data ecosystems - (Jørgensen, 2013). Applied to the specific case of the 2020 Roya Valley flash floods, we are constructing a vision to better forecast how a future data ecosystem could reduce the risks inherent to population evacuation. More practically, we are conducting interviews with experts and actors involved in the management of this disaster to propose a vision that will address the two research questions (on the specific case of the Roya Valley). We also briefly present a preliminary vision that resulted from data analysis. This vision depicts a data ecosystem at the French-Italian border. This ecosystem relies on a non-profit organization – labeled Novadata – to regulate its governance and services. The proposed vision hence details the major features of the ecosystem, how it produces and maintain innovative services. It also hints at avenues to address its major challenges.

This paper is structured as follows: we first define the key concepts of this research; we then explain the visioning method and how we intend to apply it. We briefly conclude on the expected findings and contribution from this research.

THEORETICAL BACKGROUND

In this section, we define the key terms of this research. We first detail the challenges inherent to Disaster Risk Reduction (DRR) and organizational fields at borders. We then explain what a data ecosystem is, and how it can support DRR.

DRR AT BORDERS

Hazards can generate dramatic disruptions and affect human lives, thereby generating disasters. Risk Reduction (DRR) consists of minimizing exposure to hazards and strengthen the capacity to prepare for and respond to the hazards (UNISDR, 2004). For multiple reasons, it is an important stake in cross-border regions.

First, topological limits (rivers, mountains, desert) increase the gravity of storms, massive floods or droughts that affect local populations. Second, cross-border regions are often populated by critical infrastructures (such as electrical and nuclear plants) and welcome high volumes of transportation and commercial activities. Third, the lack of administrative corresondance (Darnis, 2015; Peyrony, 2020), as well as responsibility overlaps between counterparts and divergent taxonomies can hinder cooperation. In addition, each side of the border belongs to a specific state and can need to trade-off between national interests and local needs. In this context, cross-border regions can be dramatically exposed to hazards while facing important vulnerabilities.

2021 Floods along the Meuse vividly illustrate why disaster risk reduction is an important topic in cross-border regions. The Meuse represents a natural frontier along France, Belgium, the Netherlands and Germany. It hosts cross-border population, infrastructures and many commercial activities. In July 2021, a massive flooding destroyed roads, railways, electrical infrastructures, water access at the Belgian-German frontier. This required cross-border cooperation to evacuate, as well as intensive cooperation between European emergency responders.

DRR RELIANCE ON ORGANIZATIONAL FIELDS

Organizations and societies do not tackle DRR in isolation. Rather they tend to collaborate in organizational fields. An organizational field comprises heterogeneous organizations - coming from private companies, communities, governmental or international agencies – that share a common objective and frequently interact with each other (Scott, 1995, p.56). Organizational fields can be found in various sectors, including health care (Reay & Hinings, 2005) renewable energy (Marcus & Anderson, 2010), political activism. However, organizational fields remain scarcely studied in disaster and emergency management (Hannigan, 2013; Toinpre, Mackee, & Gajendran, 2018; Verweijen, 2018)

In organizational fields aiming at DRR, there are core organizations officially entitled to reduce disaster risks, such as national and local authorities. There are also more peripheral organizations that do not endorse static responsibilities (Robinson, Eller, Gall, & Gerber, 2013), but more or less adapt to authorities and populations'

needs. Communities and non-profit organizations, as peripheral organizations, have been playing an increasingly role in information production to mitigate and address disasters (Comes, Adrot, & Rizza, 2017). Core and peripheral organizations interact within the field well before a disaster occurs - through exercises, planning, communication campaigns and other collaborative projects. In France, for instance, authorities, emergency health organizations and non-profit organizations have a long experience of workshops and exercises to better prepare for floods and other disasters. Through those interactions and projects, organizational fields devoted to DRR progressively settle.

CHALLENGES OF DRR ORGANIZATIONAL FIELDS AT BORDERS

Organizational fields that aim at disaster risk reduction can suffer from information lacks in the latent phases that precede a disaster. The massive and sudden wave of refugees who arrived at the Bielorussia and Poland frontier in December 2021 provides a sad but vivid illustration of the difficulties that DRR organizational fields can face before a disaster strikes (Watch, 2021). In this case, the army units and authorities hardly shared with non-profit organizations the information that they had preliminary collected. Also, non-profit organizations faced a dilemma between sharing unreliable information with the refugees on a humanitarian corridor. While this man-made disaster remained difficult to fully anticipate, humanitarian disasters had already taken place at frontiers. One could assume that information exchange could have help alleviate the suffering of families trapped at the borders. In sum, while organizational fields that prepare for disasters that transcend borders (Hannigan, 2013), they still face multiple obstacles to information sharing.

One reason for the lack of information and data sharing stems from the fact that data collection usually starts once a disaster hits (Haak et al., 2018). Another issue comes from the lack of coordination and transparency between organizations that collect data in about potential disasters. Organizational fields can address those issues by strengthen their capacity to effectively deploy data tools before a disaster strikes, - labelled as data preparedness (Van Den Homberg, Visser, & Van Der Veen, 2017).

We detail in the following section how data ecosystems can support data preparedness, thereby paving the way for the identification and prevention of disaster risks.

DATA ECOSYSTEM: AN AVENUE FOR DRR AT BORDERS

Data ecosystems represent a promising answer to many grand challenges, going from smart cities, agriculture resilience, sustainable development (Cave, Gyateng, Lalande, & Lumley, 2018). Recently, data ecosystems were examined as opportunities to foster information sharing and integration within organizational fields that prepare for disasters. For instance, they support collaborative tracking of population distribution during disasters (Arai et al., 2020). They can also help mitigate risks inherent to disasters, such as floods in Nepal (Van Esch, Van den Homberg, & Boersma, 2021). Data ecosystems also strengthen social and informal ties within an organizational field through networking and resource-sharing (Oliveira, Oliveira, Batista, & Lóscio, 2018).

A data ecosystem gathers organizations and actors that frequently interact with each other to produce, share, consume data sets and services (Oliveira et al., 2018). According to this definition, various kinds of organizations – companies, communities of practice, non-profit organizations, international agencies, etc. - coordinate to share multiple data sets and services. For instance, in the humanitarian sector, Open Street Map developed a new data ecosystem called HOSM (Humanitarian Open Street Map - www.hotosm.org). This system aims at making various types of humanitarian data accessible. HOSM gathers various organizations that target opportunities provided by data sharing and analysis. HOSM relies on CKAN, an open-source program supported by a worldwide community and accessible on GitHub. Some of its data sets are provided by international agencies such as the United Nations and the Red Cross. Finally, its board comprises companies such as Google, the World Bank and universities.

The selection and processing of data sets, far from being neutral, depends on organizational and social settings (Baack, 2015), even in the emergency or humanitarian sectors (Mulder, Ferguson, Groenewegen, Boersma, & Wolbers, 2016). In the case of data ecosystems, the sharing of data sets, taxonomies, as well as the governance and the involvement of community networks can influence data preparedness (Haak et al., 2018).

One can also infer from the literature how ecosystems can support DRR in organizational fields at borders. First, situational awareness fuels from inter-organizational networks and central hubs (Ansell, Boin, & Keller, 2009). By meeting both requirements of decentralized governance and pivotal leadership, data ecosystems support situational awareness. Second, data ecosystems can constitute a first step in establishing shared protocols, thereby facilitating the creation of synergies between actors during the preparation of the disaster (Gelhaar, Groß, & Otto, 2021). Third, a data ecosystem can represent a common goal that federates actors. Cross-border cooperation relies heavily on the capacity to surpass conflicts of interests (Leloup & Gagnol, 2017), and to sustain local actors'

commitment (Princen and al., 2016). For it to be maintained, mutual interdependencies, shared advantages or a continuing sense of emergency must be perceived by all actors (Princen and al., 2016). A data ecosystem might be able to fulfil the role of a driving force in cross-border cooperation (Gelhaar, Groß, Otto, 2021; Oliveira and al., 2018).

However, data ecosystems imply uncertainties that might interfere with the challenges inherent to cross-border cooperation. First, data ecosystems require multiple areas of expertise, coming from server maintenance, to programming, data cleaning and visualization, data safety, etc. The necessary expertise might not exist within one organizational field. This means the need to expand the field by including experts and private companies that master these topics but hardly know the reality of disasters and borders. Second, the underlying tenet of data ecosystems is that organizations aim at sharing information and data. However, organizations retain information and overprotect data confidentiality. Moreover, organizations might not share the same interest in data. Finally, data ecosystems imply complex governance and the capacity to plan and fund the maintenance of the data services, literacy, and sets. Cross-border cooperation can face tensions due to divergent cultural, political and economic settings between the two sides of the frontier. All these challenges imply that data ecosystems, after all, do not always offer benefits and can generate tensions between its members

In sum, data ecosystems represent a promising but uncertain avenue to support DRR at borders. Before settling ecosystems, organizations ought to better understand how data ecosystems from a socio-technical stance. We argue in the coming section the relevance of visioning as a lens on data ecosystems.

VISIONING AS A LENS TO DATA ECOSYSTEM AND DRR

A vision is defined as "*a desirable or preferable future*" (Jørgensen, 2013, p. 142). In other words, it consists of reflecting on how to improve fragments of society (including an organizational system). It is also a strong driver to involve stakeholders in the exploration of an alternate and more desirable future (Smith et al., 2005). For instance, visioning was used in participative projects with respect to a large spectrum of topics: urban spaces and city development (Szpilko, 2020), industry expansion (Hung, Lee, & Wang, 2013), innovation (Schirrmeister & Warnke, 2013), nanotechnologies (Schaper-Rinkel, 2013) and environmental solutions (Jørgensen, 2013).

Rather than merely examining what already exists, visioning helps thinking out of the box and explore what *could* exist. Visioning is therefore relevant to identify benefits from technology whose contribution to the society remains unclear and unbounded (Jørgensen, 2013). As reviewed here in, data ecosystems have been scarcely investigated and case studies on data ecosystems are missing, especially in relation to disaster risk reduction.

An underlying tenet of visioning is that technology is socio technical. Applied to our case, this means that data is not merely programs or lines. Rather data becomes what organizations practically use them. The sociotechnical dimension of data was extensively documented (Mulder et al., 2016). In other words, visioning helped us approach data ecosystems from a comprehensive fashion.

From a more practical perspective, visioning supports the involvement of practitioners in discussion with scholars and peers on the following aspects: i) whether the future prospect? is significantly preferrable to the current situation, ii) whether the future prospect is achievable. This generally helps build consistent and relevant visions that can inspire decision-makers.

RESEARCH DESIGN AND METHODOLOGY

Our research design is part of a wider project that involves a researcher, master students and a practitioner. In a nutshell, this project aims to train master students to employ scientific methods to address practical needs in organizations. This means that 8 master students –acknowledged at the end of this paper - got involved in the project from its very beginning and participate to its every step.

Based on a retrospective examination of data and information exchanges from the case of the 2020 Roya Valley floods, we are applying the visioning method to better understand how a data ecosystem can help reduce risks. Visioning aligns with a pragmatist epistemology, that posits the need for research outputs that bring practical value to our world. Here, we hope work aims at producing knowledge that can make the difference by helping humanitarian/emergency organizational field benefit data ecosystems as present and future opportunities. In this section, we first briefly present the empirical case study (as a basis of the vision) and detail each of the steps that compose our research process.

Empirical case studies: 2020 Roya and Vésubie valleys floods

To frame a desired future, visioning requires thorough understanding of past and present (Jørgensen, 2013). To support the relevance and reliability of our visioning, we are thoroughly examining information integration and inter-organizational cooperation in a past disaster at borders. This conducted us to empirically investigate the 2020 Roya flash flood case.

On 1st of October 2020, a storm labeled as Alex affected the Britanny coast in France. After some hours, the storm resulted in heavy rains and flash floods in the Roya Valley, at the French-Italian frontier. Thanks to the tracking of disaster risks, a significant proportion of citizens at risk evacuated and the authorities organized ad hoc shelters. However, the floods generate more dramatic damage than anticipated and numerous roads closed as the evacuation was still going on. Part of the evacuation was undermined by the fact that roads got blocked by heavy rains at both sides of the frontier. In this specific case, the risk of populations being blocked and unable to evacuate early enough materialized. As a result, more than 1000 firefighters were deployed to rescue, using helicopters This risk implied more fatalities, as well as demanding and dangerous solicitation of the civil protection. In line with this view, our exploratory interviews suggest that organizations put a lot of efforts on evaluating the need for evacuation and population's isolation. However, in this case, the detection of early signs represents a core challenge.

Visioning as a research process

Based on visioning heuristics and method, our research process follows three major steps. We first define the scope of the vision. This step, still on going, relies on literature reviewing, expert interviewing, and thorough investigation of 2020 Roya Valley floods. Second, we backcast, i.e., elaborate a specific vision that represents a desirable future. Third we collaboratively evaluate and discuss the feasibility of the proposed vision, which can lead to its refinement. This step focuses on the drivers and the challenges inherent to the data ecosystem settlement and maintenance. We detail in the remainder of this section each step, in particular how data is collected and analyzed.

Scoping the vision

First, as prescribed by Smith et al. (2005), we are designing the major features of our vision: time horizon, scope (including the definition of the issue to address). We determined the vision as an evolving path; the major differences to expect between present and the visions. We also detail the role of infrastructures and their main features, based on our literature review on cross-border cooperation, information integration and data ecosystems. We also examined the actors who should appear in the vision or collaborate with the research team to draw the vision.

To identify the actors involved in the vision, the research team examined two humanitarian data ecosystems and interviewed experts. We conducted three semi-structured interviews from experts of data ecosystems, including two practitioners involved in humanitarian or emergency data ecosystems and one scholar. These interviews helped refined the interviewing guide that we had elaborated from our literature review.

To ease the scoping of the vision, we relied on the concept of organizational field that helps delineate the actors involved in disaster risk reduction.

In addition, we collected and are still collecting data on the specific case of 2020 floods in the Roya valley. To specifically define the differences between present and desired future, we narrowed the scope of our investigation to a specific risk and period of the disaster under investigation. Hence, we are currently conducting interviews with actors involved in disaster mitigation in the Roya Valley (we provide in this paper a description of the case). The interviews aim at targeting diverse actors to triangulate data and we conducted based on a dictionary them that we iteratively refine after each exploratory interview. Through the interviews, we remain vigilant regarding the diversity of risks that the actors needed to address and how this affected the response. During the interview, we ask the actors about their experience of disaster risk reduction, as well as their cooperative ties. We focus on a specific risk and ask them what type of information would have eased disaster risk reduction, how they could find this information and with whom they intend. A third part of the interview.

Our rationale for focusing on this specific risk is double. First, the difficulties from the population to evacuate was reported as a major issue during the 2020 Roya Valley flood. The lack of timely evacuation put people and rescuers in danger. It also implied the need for additional helicopters and associated means to evacuate. Second, organizations have access to data that could help mitigate this risk; hydrometric data, roads exposed to floods, demographics, etc. Hence, identifying ways to mitigate this risk by relying on data seems at first sight feasible.

Backcasting

The second step consists of defining the vision itself. Its expected output is the storyline of a fictious vision, where a data ecosystem exists between cross-border organizations and supports risks' identification and mitigation. As mentioned here in, we are currently focusing on the specific risk that the populations cannot evacuate due to closed road. To elaborate a comprehensive vision, we also need to identify the major stakes inherent to the situation envisioned.

At this stage of our research, we are collecting data from multiple interviews, still in progress. We intend to attain semantic saturation, which means that our dictionary theme will not evolve over interviews. These interviews are or will involve various types of professionals involved in disaster risk management inherent to the 2020 Roya Valley disaster. We will interact with mayors, professionals in various organizations (including State agencies, civil safety, non-profit organizations) whose mission is to identify and mitigate risks. We will also interact with the operational actors involved in the rescuing of the population during the disaster. The diversity of interviewees helps manage biases against the perception from the interviewees. The combination of primary data from interviews and secondary data from the archives has so far helped us identify one specific risk that was crucial to manage before the floods. We also ask the interviewees about their contribution to risk reduction before, during and after the disaster. We then pursue the interview on the informational needs from the actors who manage the risks under study. When possible, we will ask the interviewee about data sharing and modalities to develop this sharing.

To frame our visions, we need to code the collected data, thorough analyze a specific episode (that will serve as a basis in the comparison between present and preferable situations). We are currently coding the interviews. We are using the refined dictionary theme as a starting point to identify codes in the transcripts of the interviews. Using MaxQDA, we will not restrict our coding to the codes included in the dictionary theme but will also open to other themes. Due to our focus on data ecosystem, we will carefully identify data and information needs between the actors. Based on dialogically reasoning, we are leading multiple rounds of discussion to define the most relevant codes (using memos on MaxQDA). TO test the reliability of our coding grid, we conducted cross-coding (>50% of convergence)

Finally, we are focusing on a specific episode related to evacuation and roads closure. This helps better target data to depict a situation where actors could not access to data, identify which organizations could have. Our codes will also comprise the features of a data ecosystem and its challenges for organizations. We aim at theoretical saturation (the model will not evolve despite additional models) and on two models i) a process-based model, ii) a data ecosystem-based model. These two models will help compare the present and the vision.

Collaborative discussion with practitioners

The third step will take place as a formal meeting in which we will present the vision, organize discussion on its major features (based on Haak et al., 2018) and collect inputs from participants. Based on our interviews and coding, we are currently identifying the most problematic – if not controversial - aspects of the vision that we will propose. Those aspects are detailed in the provisional findings.

PRELIMINARY FINDINGS

In this section, we detail the vision inferred from the coding of our data and a literature review. The vision does not provide an exhaustive narration of the future of data usage in cross-border regions. The vision is not normative (nor ideal) and does not call for direct implementation. Rather, it provides some of its most important features (according to our analysis) that address and foster discussion of the two following research question:

1. "*How can an organizational field located in a cross-border region rely on a data ecosystem to mitigate disaster risks?"*
2. "*What are the drivers and challenges inherent to the building of a data ecosystem within an emergency organizational field at a cross-border region?"*

The provisional vision addresses (1) by narrating a fictious data ecosystem. To promote clarity, we only provide here a summary version. In a nutshell, the ecosystem, represented in Figure 1 gathers key actors (including core and peripheral organizations of the DRR field), that would agree on the creation of the ecosystem. A non-profit organization, Novadata runs the ecosystem services and governance, under the supervision by its founders. It drives the production of data services based on public and semi-public data. The vision explains how the challenges (identified in the literature and in empirical data) can be regulated by the governance of the ecosystem.

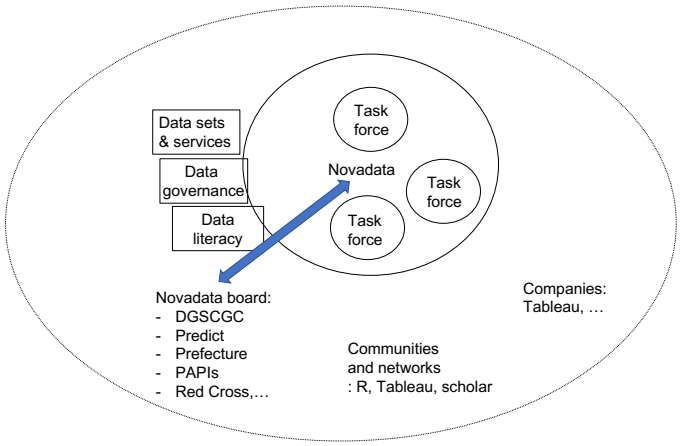

Figure 1. The visionary ecosystem and Novadata

Among its missions, Novadata designs processes to include organizations in the ecosystem and define their data rights. Novadata is also responsible for keeping the data sets and services consistent over time, through the creation of glossary and processes to update the data. Novadata also monitors the flow of data entered and shared between the various actors involved in the ecosystem.

The vision addresses (2) by proposing practical avenues to overcome the challenges inherent to the building of the ecosystem. First, not all the organizations in the ecosystem would share the same informational needs. Second, these informational needs vary over time. For those reasons, Novadata structures its services through tasks forces. Each task force specializes on a concern shared by some organizations of the ecosystem. As a starting point, Novadata creates two task forces. One on the identification and connection to vulnerable people, an another one on evacuation.

The latter targets creative use of data with respect to evacuation. The taskforce produces and updates specific datasets from the combination of semi-public data that usually remain underused. Thanks to sophisticated tools, evacuation has much improved in the latest years. But complementary views can complement existing insights on evacuation to reduce risks inherent to evacuation. The task force offers these services:

i. The production and normalization of data sets
ii. The production and access to outputs from data sets (including visuals, graphs, maps, etc.)
iii. The training and brainstorming sessions
iv. The documentation of the service and how to use them. The task force also aims at promoting data culture to address heterogeneous levels of expertise and familiarity with data across organizations.

EXPECTED CONTRIBUTION AND CONCLUSION

This research, still in progress, aims to better understand i) how a data ecosystem can support disaster risk reduction as a cooperation effort in a cross-border region, ii) the inherent drivers and challenges to the building of a data ecosystem by an organizational field in a European, cross-border region.

Our research, still in progress, presents some limitations. In particular, the vision fails at providing an exhaustive representation of the future (which is not the goal of visioning). However, to partially address this limitation, we plan to pursue our collaboration with practitioners – by brainstorming on the vision - to make sure that the vision does not overlook the most crucial stakes of data ecosystems and DRR at borders. In addition, the vision was inferred from data collection and verbatims, but remains a prospect (that might not correspond to the real future). To address this limitation, we keep in mind that the vision is not the future, but rather a possible future, achievable at certain conditions. In the future, we will also segment the vision (in challenges) to brainstorm on those conditions specifically.

The expected contribution from this research is double. First, we will enrich existing knowledge on data ecosystems in cross-border organizational fields. Despite growing documentation on data ecosystems, we still lack insights on the specific context of borders, which represent rich but vulnerable regions in the world. This paper also offers an example of visioning. In particular, it details the steps that one can follow to frame and investigate a potential future cross-border data ecosystems. Our second contribution is more practical. Through the visioning method, we will participate into a collaborative and prospective research to help organizations reflect on the benefits and risks inherent to data ecosystems. We hope that, by so doing, these organizations can rely

scientific methods and concepts to avoid better benefit from data.

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