BIG DATA & SOCIETY

Original Research Article

Data diaries: A situated approach to the study of data

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Abstract

This article adapts the ethnographic medium of the diary to develop a method for studying data and related data practices. The article focuses on the creation of one data diary, developed iteratively over three years in the context of a national centre for monitoring disasters and natural hazards in Brazil (Cemaden). We describe four points of focus involved in the creation of a data diary – spaces, interfaces, types and situations – before reflecting on the value of this method. We suggest data diaries (1) are able to capture the *informal* dimension of data-intensive organisations; (2) enable empirical analysis of the specific ways that data *intervene* in the unfolding of situations; and (3) as a document, data diaries can foster *interdisciplinary* and inter-expert dialogue by bridging different ways of knowing data.

Keywords

Data diary, datafication, data space, data interface, situation, critical data studies, data methods

Introduction

This article makes a methodological contribution to the social study of data and specifically to what has been called 'critical data studies' (Dalton et al., 2016; Metcalf and Crawford, 2016). Early accounts of the rise and promise and perils of Big Data (Kitchin, 2014a, 2014b; Mayer-Schonberger and Cukier, 2013) have given way to a large number of nuanced discussions around what can broadly be described as the datafication of society (Dijck and van, 2014; Es and Schafer, 2017; Mejias and Couldry, 2019; Sumartojo et al., 2016). Data and their related practices are now roundly understood to shape subjectivities (Cheney-Lippold, 2017; Koopman, 2019) and underpin political economies (Srnicek, 2016; Zuboff, 2019); to have their own political and geo-political dynamics (Arora, 2016; Couldry and Mejias, 2019; Ruppert et al., 2017) and unique cultures of practice (Lupton, 2019; Pink et al., 2017). Countering the early focus on data (and Big Data's) epistemological qualities, critical data research has stressed data's everyday or 'mundane' status (Pink et al., 2017), their materiality (Bates et al., 2016; Gray et al., 2018), situatedness (Loukissas, 2019), historical contingency (Rosenberg, 2013) and affective qualities (Kennedy and Hill, 2017; Lupton, 2017; Smith, 2018; Sumartojo et al., 2016), among other things.

Within this nascent field, a smaller number of articles have explicitly focused on questions of methodology, implicitly suggesting that critical and socially focused accounts of data require a degree of methodological inventiveness (Lury and Wakeford, 2012). These are not methods for producing data but methods that aim to make available new ways of knowing data. Alison Powell, for example, has developed the method of the 'data walkshop' which she describes as

> A radically bottom up process of exploring and defin-
> ing data, 'big data' and data politics from the

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perspectives of groups of citizens, who walk, observe, discuss and record connections between data, processes of datafication, and the places that they live in (2018: 2).

In a similar fashion, Jo Bates et al. have developed a 'data journey' method, which 'contributes to the development of critical, qualitative methodologies that can address the geographic and temporal scale of emerging knowledge infrastructures, and capture the "life of data" from their initial generation through to re-use in different contexts' (2016: 1). After noting that 'critical research on emergent "Big Data" practices and infrastructures has remained at the conceptual and theoretical level', these authors identify:

> A growing need for methodological approaches that are able to capture detailed empirical understanding about 'Big Data' in practice, including how socio-material factors influence the constitution of data objects and shape how they move through space and time connecting different sites of practice across vast data infrastructures. (2016: 2)

In this article, we take up Bates et al.'s call for additional methodological approaches through a presentation and reflection on the creation of a *data diary*. Similar to Bates et al., we are interested in understanding existing 'data practices' empirically (2016: 2). While Bates et al.'s approach is designed specifically for understanding how data move across sites, our approach focuses on a single site and specifically on what has been referred to as a 'centre of coordination' (Suchman, 1997). A data diary aims to understand what data do, how they move, are drawn upon or ignored, and generally co-constitute a given spatial situation.

In what follows, we do not present a diary in completed form, but rather provide a reflexive overview of how we went about creating a data diary. Our goal is to offer a general guide for others who wish to study data empirically in a predefined space or organisation, and to make a case for the value of such a method. We begin with an introduction to the site within which the data diary was created – a natural hazard monitoring centre in Brazil. We then offer a more detailed account of the diary as method before narrowing to the data diary. We present four points of focus for the creation of a data diary – data spaces, data interfaces, data types and data situations – giving examples of how each was documented in the diary. By attending to space, interface, type and situation, the idea is that the researcher builds an understanding of what we call 'data-intensive situations' gradually, beginning with a general understanding of what the space is for and

eventually being able to grasp data's role in the unfolding of situations (Suchman, 2006). We conclude by offering three ways the production of a data diary contributes to understandings of data: (1) by making visible the *informal* dimension of data-intensive organizations; (2) by enabling empirical analysis of how data *intervene* in the unfolding of situations; and (3) as a document, they can foster *interdisciplinary* and inter-expert dialogue by bridging different ways of knowing data.

The case: Cemaden

The Brazilian National Centre for Monitoring and Early Warning of Natural Disasters (Cemaden in Portuguese) is located in a technology park on the outskirts of São José dos Campos, a medium-sized city approximately 80 km north-east of São Paulo city. Cemaden was established in December 2011 as a direct response to the landslides and flooding that occurred in the state of Rio de Janeiro in 2010, which resulted in the death of 916 people and left a further 35,000 displaced. Since its establishment, researchers at Cemaden and affiliated organisations have identified 43,000 areas in almost 1000 different municipalities across Brazil which host communities that are vulnerable to severe landslides, flooding, flash-flooding, or ponding. Cemaden uses more than 4750 rainfall gauges, around 550 humidity and rainfall sensors, 9 weather radars, and almost 300 hydrological stations to monitor weather-related events that may affect these vulnerable communities (Horita et al., 2017).

Within the larger Cemaden building sits a fully enclosed situation room and it is in this room that the actual monitoring of weather to identify possible natural hazards that could lead to disasters occurs. The situation room is staffed 24/7 by teams of four to seven specialists, working 6-hour shifts without break. Each team is comprised of different specialisations, including at least one meteorologist, hydrologist, geo-specialist and disaster specialist. The specialists' roles are designed such that they work semi-independently with clearly differentiated tasks, although we observed a strong tendency to work collaboratively, especially in times of pressure (as discussed below).

The specialists in the situation room have two main tasks. First, they issue warning reports and make decisions about whether or not to issue warning reports. Second, they produce a daily geo-hydrological risk map (see Figure 1). While both activities rely heavily on data, our focus is on the issuing of warning reports.

Within the team, it is often the meteorologist who draws the group's attention to an area of concern. Changing atmospheric conditions such as the movement of a storm front are the first indicator that a
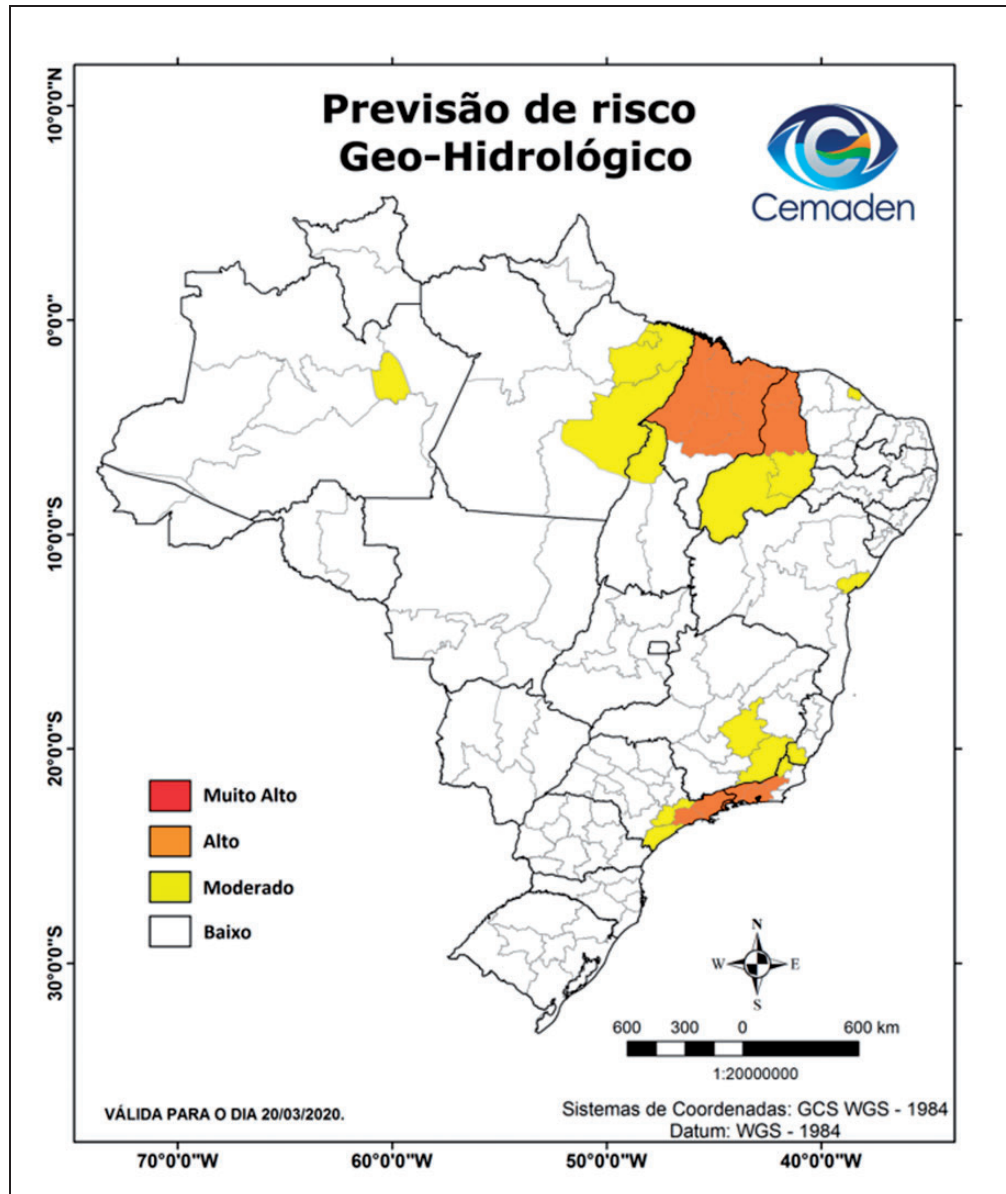
Figure 1. Geo-hydrological risk prediction map for 20 March 2020.
Source: https://www.cemaden.gov.br/20032020-previsao-de-risco-geo-hidrologico/

risk of disaster (or 'situation') may be present. Once identified, the rest of the specialists draw their attention to the area and monitor it more closely, using numerous visualisations, images and other representations of data from a variety of sources to decide whether or not a warning report needs to be issued. During normal operation, only the hydrologists and geologists issue warning reports.

We consider Cemaden an ideal case to study data within a sociotechnical context. Previous studies have indicated that Cemaden is a notable example of decision-making within a 'big data' context (Horita et al., 2017) and also suggests more participatory observations should be conducted in the situation room in order to better understand quotidian data practices (Horita et al., 2018). Finally, without wishing to revisit debates about what constitutes Big Data, in Kitchin's influential writing on the topic he notes that 'Big Data has existed in some domains, such as remote sensing, weather prediction, and financial markets, for some time...' (2014a: 2). As a weather monitoring centre with the majority of data generated through remote sensors, the situation room in Cemaden would appear an ideal site to investigate what Kitchin refers to as the 'new epistemologies' enabled by Big Data. While we are less interested in whether or not

the epistemological character of activity in the situation room are uniquely attributable to Big Data, we strongly agree with Kitchin's call for a 'situated and reflexive' approach (2014a: 10). Our data diary of Cemaden is an attempt to present data in such a way that their situatedness is prioritised so as to enable more reflexive data epistemologies.

Data diaries

Ethnographic research has at its disposal many forms of writing. Rojer Sanjek has observed that the term ethnography refers to both a process and a product (2013: 59), and one can see this reflected in corresponding forms of writing, or what Karen O'Reilly once broadly categorised as the difference between 'writing down' and 'writing up' (2005: 175). Methods such as 'scratch notes' or observational 'jottings' are rough attempts to capture the empirical as it unfolds, while field notes, journals and diaries are typically more reflexive, written post-experience and are organised in different ways (Emerson and Fretz Ri Shaw , 2011; O'Reilly, 2011; Sanjek, 1990, 2013). The forms are many and varied and can be brought into different types of relation with each other and the wider media ecology of ethnographic research.

The diary has its own historical trajectory and position within the spaces of ethnographic writing. While diary and diary-like forms of writing (personal, informal, narrated, etc.) are found across a number of disciplines as well as beyond academia, the diary's ethnographic significance came to the fore with the posthumous publication of Bronislaw Malinowski's *A Diary in the Strictest Sense of the Term* (1967/1989). Malinowski's *Diary* contrasted starkly with the style and content of other published ethnographic writings, including his own previously studies. The *Diary* was filled with personal reflections, doubts, and ambitions. The form of Malinowski's *Diary* itself provides a kind of *medial* critique of its more finely crafted counterpart (the written-up ethnography). Both as a process and product, diaries have remained a staple of the ethnographer's toolkit and have been consciously and performatively played with as a literary-ethnographic medium, where the active role of the researcher and their relation to the objects of study can be self-consciously and stylistically explored (Clifford, 1997). And, of course, diaries are used in a variety of other ways, for example, as collaborative creations or as a form of self-documentation for the subjects of research (Collins et al., 2010).

Our data diary draws selectively from and repurposes this tradition of ethnographic writing. At the most general methodological level, a data diary is a strategy of notation. Its purpose is to produce an account of data and related data practices within a sociotechnical setting. It is, then, a method uniquely interested in providing an ethnographic account of data, but one in which the role of humans recedes such that data can come into focus. While there may be different types of data diaries, we consider this method to be necessarily informed by critical perspectives on data and related topics (software, interfaces, visualisation, infrastructure, and so on). A data diary aims to operationalise critical insights for methodological ends.

We use the term 'data diary' to refer to this general methodological orientation ('an account of data and data practices') but also to its final output – in our case, a data diary of Cemaden's situation room. We do not clearly distinguish between process or method and end product because the steps involved in moving from process to product, of deciding what goes into the 'product', how it is to be arranged and presented, is itself still part of the process or 'method'.

When it comes to actually making a data diary, this general methodological orientation can be realised through a variety of related techniques and indeed, other methods. That is to say, a data diary is composite. For example, our diary was comprised of scratch notes, jottings and more lengthy written reflections, but we also included photographs, excerpts from technical manuals, diagrams, illustrations, wall-posters and a number of slide presentations that were shared with us by Cemaden staff. While a data diary makes use of any number of other techniques and methods, these are all brought under the organising logic and methodological orientation of the data diary.

Our diary was in equal parts written, captured and compiled. It was a collaborative affair, iterated on by a number of researchers over a period of three years (2018–2020). Specialists within the situation room in Cemaden, as well as other researchers and managers in the centre added elements to its construction and provided feedback as it was refined. The diary weaves a path through the disparate knowledges of the researcher, the IT system manager, the situation room manager, the respective specialists, and Cemaden's researchers who work outside the situation room. As a collaboration, then, at times it blurs the distinction between researcher, participant and their respective domains of expertise. What enables this collaborative blurring is the subject (matter) of the diary.

Diverging from the tendency of the diary genre, a *data* diary does not unfold as the personal narration of a human subject. Since data are the focus, as a form the data diary has more in common with the 'it-narratives' (Blackwell, 2007) of the 18th Century, where the narrative unfolds through 'the autobiography of something not human, formerly inanimate but now

inspired with enough passion, reason, and speech to launch upon its own story' (Lamb, 2016: xxviii). Unlike these it-narratives, we make no attempt to anthropomorphise data, though we do wish to bring forth data's participation in affective modes of being. Since the narrative and biographical thrust of the diary is not linked to an individual, this opens up the author position to a range of possible occupants.

The process of diary creation is ultimately geared toward a final product, upon which a curated selection of the material gathered and developed are included. The criteria upon which these decisions are made will vary depending on the specific goals of the diary. In our diary, we wondered about how best to visually represent and include human-data interactions, for example. We also wondered whether or not and how to include slides from the IT manager that diagram certain infrastructural elements underpinning the situation room. These are the types of questions we found ourselves discussing when moving from process to product.

Before detailing the process of creation of the Cemaden diary, we wish to add a final point regarding what we see as the onto-epistemological stakes of diary creation. Perhaps more so than other forms, diaries raise the question of the authority of inscription. Historically, diaries may be contrasted to more official documents, such as reports and other bureaucratic documents, and this contrast is equally one of style. The diary may become an important historical document (part of the 'historical record', so to speak), but it is typically produced with different authorly intentions. While there are no strict conventions, it may be characterised by more intimate and reflexive passages. A diary may blend the observation and description of events with a sense of how these events were experienced at the level of subjectivity. Without wishing to revisit whether or not a diary 'reveals some more primordial truth' (Hutnyk, 1998: 350), we consider data diaries as spaces of epistemological encounter; spaces which enable the creation of emergent truth-values in distinction to more established ways of presenting data. Specifically, a diary can operate across different epistemological registers, bringing together, for example, a formal diagram of decision-making, a sketch of desktop display, and an off-the-cuff remark by a specialist under duress.

A data diary

In what follows, we offer a number of points of focus for the construction of a data diary. We arrived at these iteratively, through reflecting on the material gathered and discussions held during our first few visits to Cemaden. Our four focus areas – data spaces, data interfaces, data types, and data situations – therefore emerged through the process of diary production itself and in relation to the specificity of the case. Other diaries based on other cases could look quite different, though it is hoped that documenting our points of focus provides a useful point of reference. What we offer is a narration of how the diary was constructed, what each point of focus adds conceptually, and examples of what we included.

Data space

Our data diary was produced in a concrete and relatively bounded site. Data, of course, do not respect these boundaries, but our aim was not to follow the data but to better understand what data did in a given context or situation over time. The diary began with our first visit to the room and an initial walkthrough offered by a scientist and former situation room manager, who was also a collaborator on the larger research project within which the creation of the data diary was a part. Upon entering the room, we walk up a broad entrance hallway with a slight incline. After entering, we emerge at what is the rear of the room in terms of orientation. As an initial exercise, we mapped the space of the situation room. The room was sketched and later diagrammed, focusing on the position of sources of visible data. Similar to earlier accounts of how the presence of code is constitutive of the spaces in which it is present – creating an emergent code/space – our method is also interested in understanding how data and space intermingle to create new spatialities (Kitchin and Dodge, 2011). The first task is to sketch the room layout paying attention to the presence of data (see Figure 2).

The first thing to note about the room is how it is dominated by the wall-sized screen, or *Telão* ('big screen') as it is called in Cemaden. Comprised of 32 separate panels, the *Telão* extends the width of the room and most of its height, bar a couple feet near the floor which would not be visible from the desks. The room declines slightly towards the *Telão*, further emphasising its significance. It is the most visible and immediate presence of data in the room (see Figure 3). During our first visit, we were steered to the front of the room in the space direction in front of the *Telão* and the manager-come-guide explained the operation of the room from this position, making occasional gestures to the screen for support. Once we had become more established in the room – and having occupied one of the workstations – we noted that other tours of the room were typically delivered with a focus on the big screen and by shepherding visitors to the front.

The room itself is filled with four rows of work benches, with access ways on the far left and far right of the room (to access the front). Each row has five
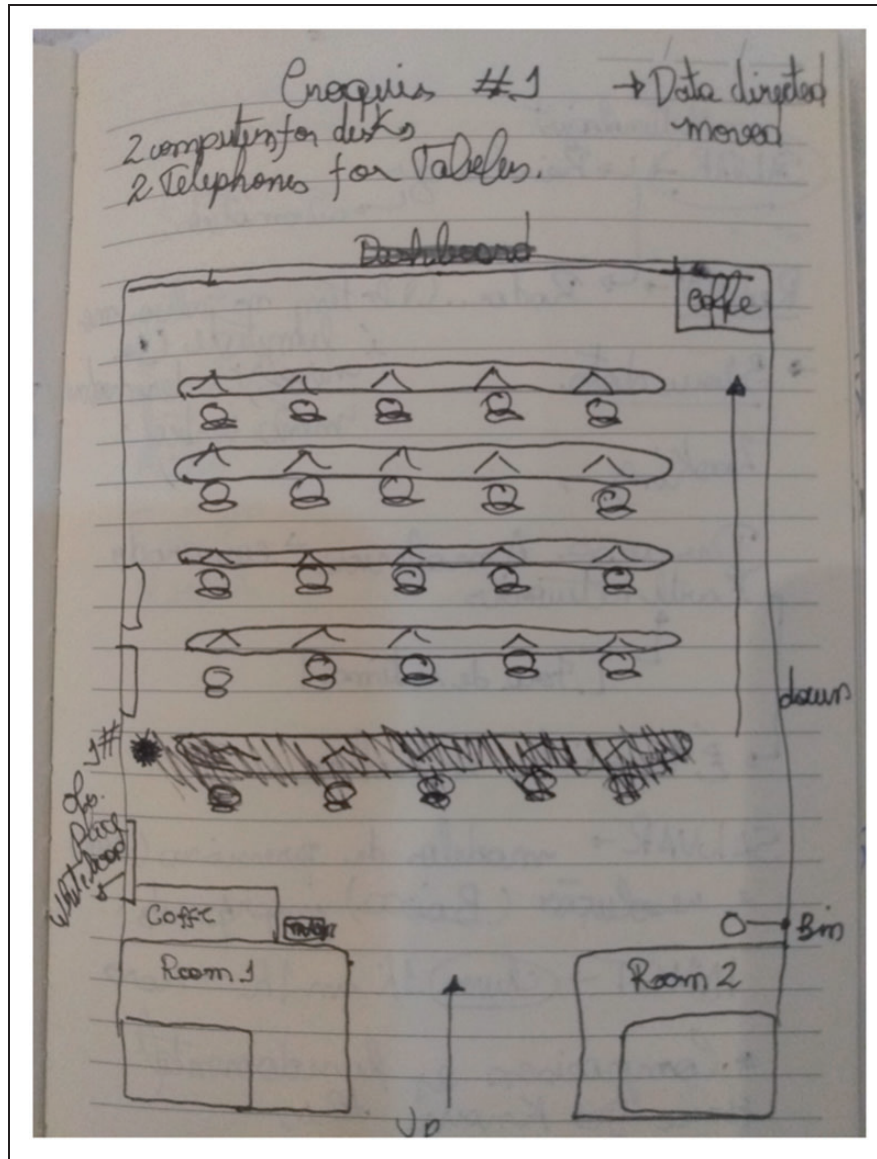
Figure 2. Sketch of the Cemaden situation room. Source: Authors.

workstations and each of these two monitors, a keyboard and mouse. Besides the *Telão*, these workstations were a clear focus point for the presence of data. While the room's specialist operators would often move around, each would select and configure a workstation to their preferences and typically spend extended periods of time sitting at the station. Besides the wall screen and the workstations, there was another single screen display on the left sidewall, often used for videoconferencing. At the rear of the left sidewall was a whiteboard, with some numbers noted down. We asked about the numbers and this other screen but will not detail them further here.

Spatially, the situation room is organised to encourage a specific kind of 'data gaze' (Beer, 2018).

The whole room is oriented towards the *Telão* which in turn imposes itself. More than anything else, the *Telão* sets the tone of the room. The workstations offer configurable spaces for the individual specialist's data practices. This spatial configuration also has a performative element to it. The *Telão* itself partly fulfils this performative function in its very form. It lets everyone knows what kind of space the situation room is. When receiving visitors, the situation room's specialists play up to the presence of the big screen, directing visitors to the front and gesturing to it often. We note, however, that many of the data practices we observed took place through workstation interactions as opposed to the screen.
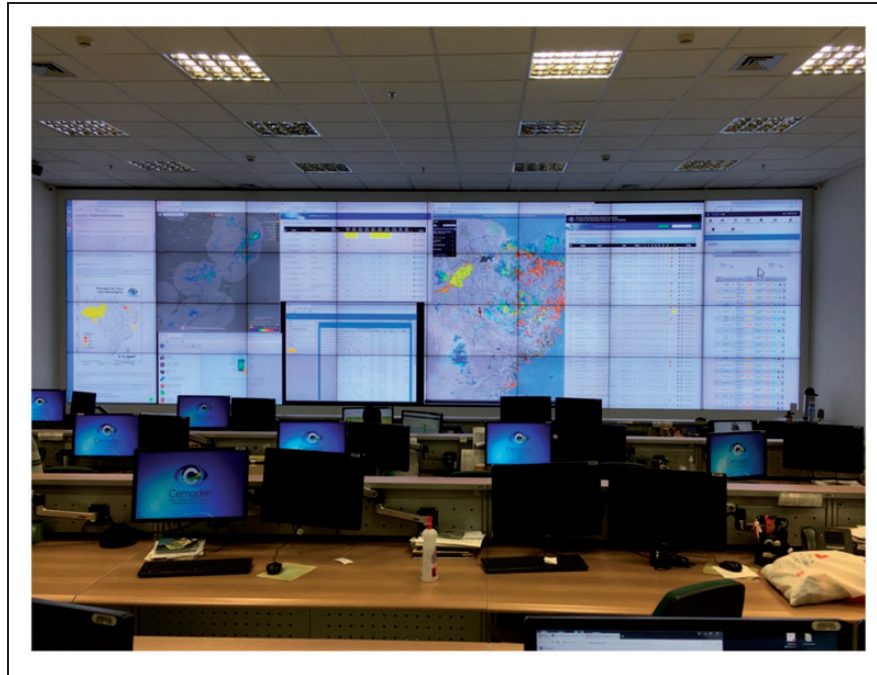
Figure 3. Photograph of the situation room. Source: Authors.

Focusing on data and space, on where data are, how they move (or not), as well as on the material arrangement and interaction of things and people in relation to data carries on the approach proposed by Kitchin and Dodge in *Code/Space* (2011), with the slight adjustment of focusing more specifically on data. Based on the recognition that space is always a production (Lefebvre, 1991), Kitchin and Dodge explored the specific ways the code transforms space, or rather that code and space mutually constitute and 'transduce' each other. Code/spaces are those within which 'spatiality is the product of code, and the code exists primarily in order to produce a particular spatiality' (Kitchin and Dodge, 2011: 16). Given that Kitchin and Dodge also use control rooms as one of their examples of code/space, it is indeed a small step to extend the argument to data. Recent developments in 'data-driven' algorithms and software tools require us to shift from a static view of a deterministic, reified 'code' to emphasise the importance of data for understanding emerging behaviour and practices around software. Translating Kitchin and Dodge's ideas to think about data and space, what we get is a recognition that data are not just *contained in the space of the situation room* but rather *is co-constitutive of the situation room as a 'data/space'*. Put simply, without data on the *Telão* and the workstations, the situation room is no longer such. Everything from the arrangement of the room to the identity of the people who reside there, or the

room's function in relation to 'situations', is dependent on the presence of data.

Taken for granted within this spatial, transductive approach is an understanding of data as material as opposed to somehow purely items of knowledge. Data are entirely dependent on material infrastructures (buildings, electricity, screens, information systems, radars, etc.) but also only exists through specific material instantiations, as things sensed through sensors, passing through many mediations before being displayed through a bundle of screen technologies, hardware and software. In this way, data cannot clearly be separated from their infrastructures. This reality (of data/space) was made bluntly enough during one visit where, during a storm, the power went out in the situation room. Without the *Telão* and the workstations, the space was no longer a situation room. It lost its sense of 'eventness' and any capacity to monitor the weather.

Beginning with a narration of data and space involves a consideration of where data are, but also how they act to constitute space itself. Sketching and diagramming the room is thus only a starting point – a first step in a more processual understanding of spatial dynamics. What such diagrams do make visible are the broad strategies of spatial configuration of the situation room as a data space. We found that sketching the space daily (noting any changes) and complimenting this with other more specific observations (such as

changes in the configuration of the *Telão*) gave a better sense of the room's dynamic production of data space.

Data interfaces

The interface has long been a privileged object for considering the social aspects of human-machine interactions, from the rise of ergonomics and 'human factors' to more recent user experience design and the emerging area of interface criticism (Andersen and Pold, 2011, 2018; Harrison et al., 2007; Hookway, 2014; Suchman, 2006). As early designers of computational systems that support decision making observed, 'The system, as seen by the users, *is* the interface' (Keen and Morton, 1978: 182). In our case, the interface is where data come to matter; where their transductive force is enacted and their capacity to intervene in the situational dynamics of the room – dynamics they also co-constitute – are realised. While interface analysis can go in a number of directions, for the creation of data diaries it begins with a simple question: What kind of data are displayed on the interfaces in the data space of the situation room? Note, we acknowledge there are many types of interface (Cramer and Fuller, 2008), though our focus is on human–computer and specifically graphical user interfaces. Having identified the *Telão* and the workstation displays as the two most important interfaces, we focus on these.

Telão.

During our first visit to Cemaden, we were given a brief overview of the *Telão*. On a subsequent visit, however, we asked a former situation room manager for a more detailed explanation. What we had in mind was similar to a software product walkthrough (Karat et al., 1992; Light et al., 2016; Mahatody et al., 2010). The *Telão* display is comprised of a number of different interface elements. We learned that the display itself is actually based on a regular PC desktop interface and each of the elements are windows. On the day of the walkthrough, the *Telão* contained eight interface elements (or windows). The photograph above (Figure 3) was taken on this day, while Figure 4 is a sketch of how *the Telão* is configured, with each element of the display numbered to enable cross-referencing with accompanying notes.

A key observation is that the configuration of the *Telão* is not fixed, and rather changes in response to external events as well as to accommodate the preferences of different teams of specialists across shifts. That is, the display does not only represent external events through data and related visualisations but is itself shaped by them. It is also the case, however, that there are clear patterns and regularities regarding the configuration of the *Telão*. On the far left of the *Telão*
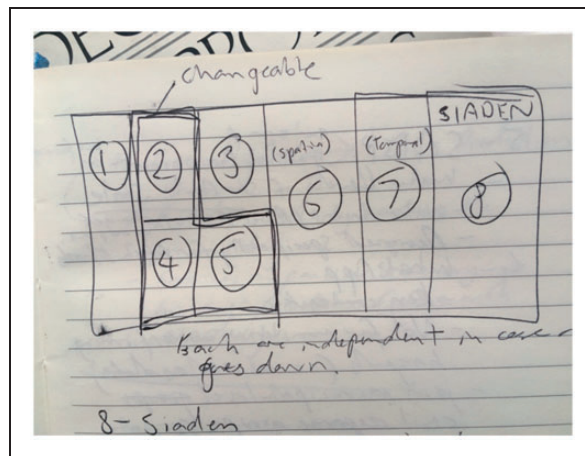

Figure 4. Initial sketch of the *Telão* interface elements. Source: Authors.

(position 1), for example, a geo-hydrological risk prediction map was always positioned. This map, the other key output of the situation room (but not our focus here), is a prediction of areas at risk made the previous day and serves a kind of memory function on the display. Likewise, the window on the far right of the display (position 8) is a specific table view of Cemaden's warning management software (SIADEN: Integrated Natural Disaster Alert System). It shows data relating to current warnings that have been issued and their ongoing status. In positions 3, 6 and 7 and windows displaying data from Cemaden's monitoring system, SALVAR (roughly, System for Alert and Visualisation of Areas of Risk). SALVAR is the system that processes and visualizes the data coming into Cemaden. In the middle of the *Telão* (position 6) is a map of Brazil. It is the main reference point on the big screen and is used for general awareness and comparison. The map can be 'layered' with different types of geological, hydrological, meteorological and risk-related data visualisations. To the left (top) and right of the map (positions 3 and 7) are windows showing more data drawn from SALVAR, but in table view and with a temporal (rather than spatial) orientation. Position 3 is displaying a line chart with data generated by hydrological stations (measuring river water levels), while position 7 is displaying data from pluviometric stations (measuring rainfall). While the map was always on the *Telão*, the two other SALVAR-related windows tended to change depending on which areas were being monitored closely. The remaining interface elements (in positions 2, 4 and 5), changed more often. During the day of the 'walkthrough', position 2 contained another map. The map (displayed via a web browser) shows rain radar data from the commercial website windy.com. Windy.com is considered a 'light'

and thus faster platform, so the data is 'fresher' than what Cemaden's own SALVAR system is able to generate. The specialists present on the day considered windy.com's rain radar data superior in terms of speed, but also recognised it was not specifically 'risk-related'. In position 4 was perhaps the most surprising of the elements on the display. This window was used for WhatsApp. WhatsApp is not used directly for monitoring or confirming hazards. They have a number of key contacts and have joined a number of (private) municipal level civil response groups to generally see what they are doing. While not always on the *Telão*, WhatsApp is used within the situation room as a kind of informal 'backchannel', to better understand what other public/government bodies are doing in relation to possible hazards. Finally, in position 5, more data in tabular form are displayed but from an external system (SAISP: São Paulo State Flood Warning System) rather than from SALVAR. On this day, it is showing changes in the levels of water and river basins in the state of São Paulo. We are told that this system is used specifically with regards to flash floods. It is through these display elements that the ratio of change and continuity is affected. As we observed, some elements are unchanging, others always show similar types of data but tend to keep their position on the display, and yet others can be replaced or altered. It is also the case that the number of elements in total can change, as can their size. Figure 5 offers a diagrammatic comparison of two configurations at different times.

A walkthrough of the *Telão* gave us a good general understanding of what goes on in the situation room. The SIADEN window on the display, for example, gave us a sense of the workflow of the room. We followed up later to learn more about this system, how warnings are issued and how the specialists use this window in terms of general awareness. We also learned that the data displayed is contingent and changes regularly. Much of the key data are generated through Cemaden's own SALVAR system, but these are supported by other external sources of data, sourced from other public bodies but also commercial companies. Finally, the display mingles these diverse and changing data with other visual and communicative elements, such as the static (PDF) map and WhatsApp. This initial walkthrough helped us orientate ourselves and opened new lines of inquiry (such as triggering us to learn more about SALVAR, SIADEN, and how the risk map is made).

Workstations.

While the *Telão* dominates the space, much of the specialist's job, including the actual issuing of a warning, happens at the workstation. How these workstations were used also varied widely from individual to individual and reflected the different expertise (and related roles) of the specialists. If the *Telão* provides a general overview of main sources of data, the systems used and the kinds of things the specialist pay attention to, the workstations are interfaces for personalisation.

Figure 6, for example, is a rough sketch of a typical workstation display. The screen on the left has a web browser window with a cloud-based email client open and other browser tabs. Because it is not a busy day, the screen is used for a range of non-monitoring-related activities. The screen on the right is set up for monitoring. This display also has a browser window visible with several tabs open. Each of the tabs provides access to different sources of data, with some duplicating the data displayed on the *Telão* but configured differently – such as data from SALVAR or SIADEN – in addition to sources not displayed on the Telão – such meteorological data from Redmet or pluviometric data from the National Hydrometeorological Network. Despite individual variance, the meteorologists, geologists, hydrologists and disaster experts all configure their workstations such that the data on display reflect their expertise and the requirements of their role within the team, with perhaps the disaster expert's display showing the most variation. The disaster expert's role involves informing the team about previous hazards and disasters in an area under attention. Since historical data on previous hazards in Brazil is limited and not stored in a single database, the disaster expert may have to conduct rapid investigations on the fly, searching anything from local newspapers to social media to determine how an area has handled similar conditions in the past.

Attention to data interfaces enables a colouring of how data space is configured. Through documenting the various elements on each display, this aspect of the data diary introduces the main systems and types of data in use in the situation room. Focusing on the display shows how data are represented in the room (largely through maps, charts and tables) and how the use of data varies across roles and between individuals. While we limit our discussion to an introduction to the elements on display and how staff configure their own interfaces, one could go much further with an interface-led inquiry, through analysis the formal qualities of the visualisations, or further unpacking the software or display technologies in use, for example.

Data types

From the interface, we narrow to the data. There are many ways data may feature directly in a data diary and after exploring a number of methods we came to
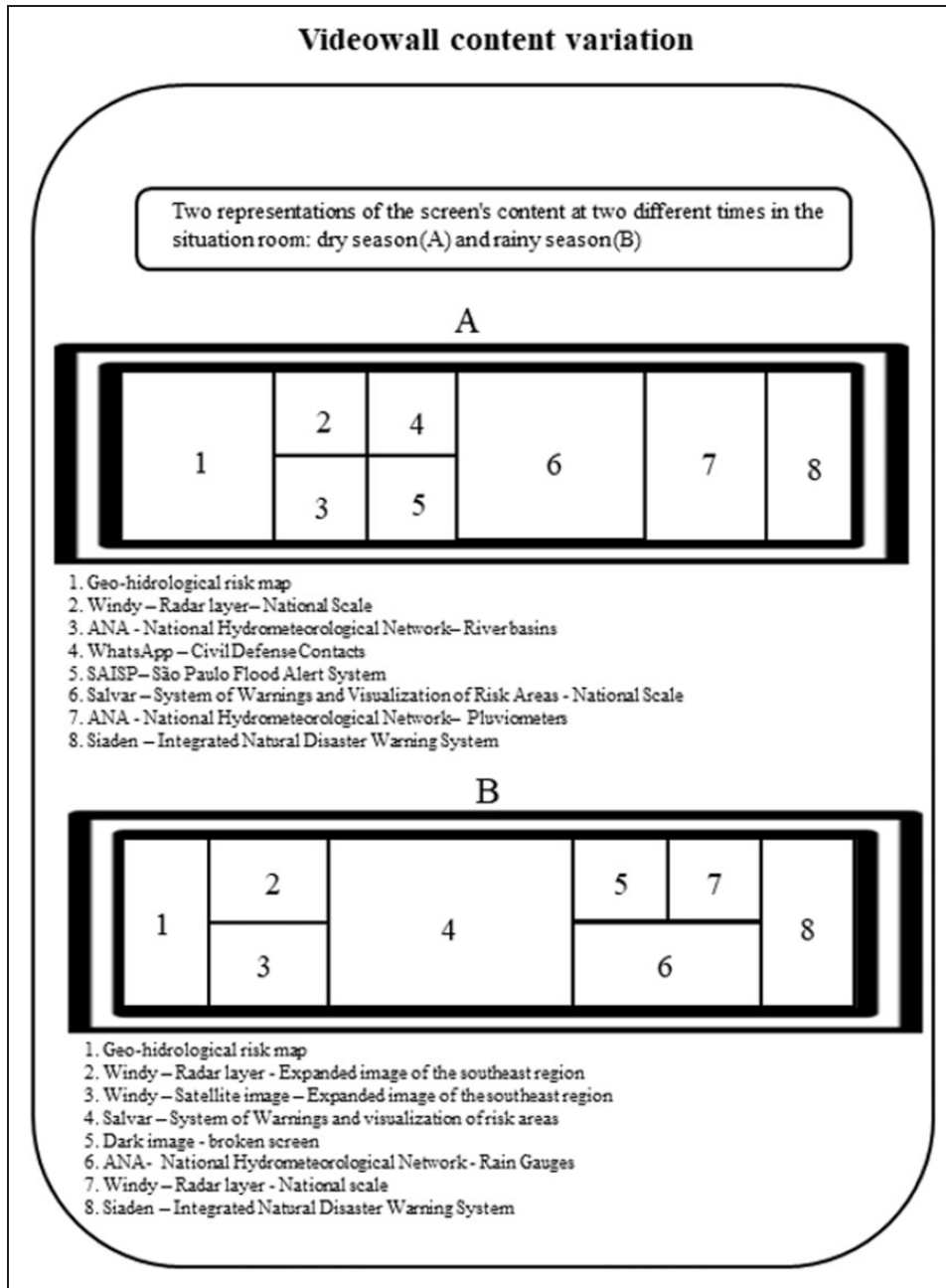
Figure 5. A diagrammatic comparison of two *Telão* configurations. Source: Authors.
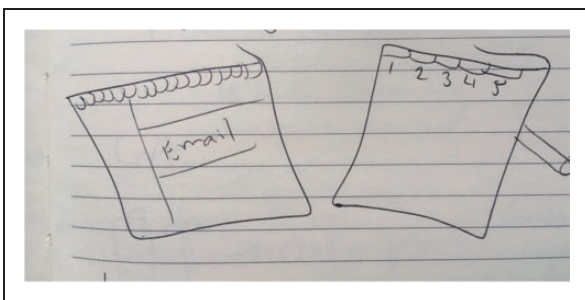

Figure 6. Sketch of a workstation display. Source: Authors.

focus on two. The first method we used involved an extension of the walkthrough-like approach used for interfaces, where we invited a specialist to tell us everything they could about a given data type, data point, or data entry (in practice these are not always clearly differentiated). Here, the point is for the walkthrough to be open-ended, such that the specialist (here in the position of the narrator) gives their unique take on the data under consideration. For example, one manager gave us a walkthrough of one data entry on the SIADEN window on the *Telão*. Each entry on the

display represents an open warning. He moved from left to right, explaining what each column refers two, using one alert (803) as an example. The table includes the following columns and input types: alert code (number); location (name of municipality); state (abbreviated name); event (risk type and risk level); event situation (colour-coded icon); opening (data and time of issue); last update (data and time); status (colour-coded circular icon); feedback (purple triangle) and visual (link to report). These guided explanations are handy as there are often details or ways of knowing built into the data that are not obvious. For example, even something as basic as the alert code is used in a number of ways. It not only provides a reference point for an open warning, but, taken together, gives a general sense of how busy the year has been and how busy the situation room is at any point. The presence of lower code numbers means there are events that have persisted for a lengthy period (such as a large flood). Such guided explanations may also lead to specialists giving evaluations of the data type, or providing anecdotes regarding its use.

A second technique we explored was creating survey-like questionnaires for different types of data, which we filled in ourselves through observing and asking questions directly. Figure 7 shows the questions we asked of the same SIADEN data. These questionnaires may be suitable if comparing data types or responses is of interest.

All in all, attention to space, interface and type can all be seen as laying the groundwork for understanding data in motion. This is not to say that these things are static or unchanging.

Rather, attention to these first three points of interest prepares the diary maker(s); it equips them with the necessary orientations, data literacies and perceptual foci to give an explicitly processual account of data and data practices. We explore data's processuality through their constitutive role in situations.

Data situations

The situation room is a data space, which means its spatial character, the *kind* of space it is, is in part co-constituted through data. The room's situation*ness* – its status as a space of situations – is also constituted through data. Indeed, data are the primary way situations are discoverable (through monitoring) and knowable, and also forms the basis upon which decisions about any given situation are made. That is, while a situation involves a number of external forces, the way a situation emerges in the room is through the monitoring and analysis of data (as this is the primary way that these other external forces are rendered visible and knowable). There is an established and diverse

literature on situation, control and operations rooms and on the notion of situations specifically, which we cannot discuss in detail (Almklov et al., 2014; Bohn, 2003; Cetina, 2009; Filippi and Theureau, 1993; Heath and Luff, 1992; Landgren and Bergstrand, 2016; Suchman, 1997; Walters, 2017; Wybo and Kowalski, 1998). We understand our data situations very much in the tradition of Karin Knorr Cetina's 'synthetic situations', where a situation is understood to be constituted through mediation or 'on-screen projections', rather than by human to human relations (2009: 65). To this we add William Walters' more specific definition as a 'time-space' that 'materializes in contexts where information, infrastructure, and reaction capabilities combine in such a way that social events and emergencies can be monitored and acted upon in near real time' (2017: 794). Thus, the situation room – its spatiality, interfaces, data, and related infrastructure – enables situations to emerge, to be acted upon, and eventually recede.

Given the methodological focus of this article, our interest here is limited to recognising and documenting the eventive nature of the room. What methods can make visible how data are put to work, how they are practiced, and specifically how they constitute and help resolve or alternatively trouble the unfolding of a situation? Although constituted through data, a data situation requires a human. Data fill the screens and structure the room, but they cannot speak and they cannot act alone – at least not in Cemaden. To document and narrate data situations, then, one must actively pay attention to the specialists.

The majority of our time in the situation room was dedicated to documenting the unfolding of data practices during a situation. We did this through a combination of observing the dynamics of the room in general and through shadowing individual specialists. Shadowing involved sitting behind or next to a specialist for short spells (typically no more than 30 minutes at a time) and occasionally asking them to verbalise or explain their actions.

While the specialists have individual roles, they generally work in a collaborative manner. It is the meteorologist's role to identifying weather patterns in need of close monitoring, and the hydrologist's and meteorologist's role to make the final decision about issuing a warning alert, however in between these moments a lot of (collaborative) activity may occur. To capture some of this activity, we adopted the 'sequence' or 'event diagram' method, which is designed to show how actors interact within a given period of time. Figure 8 shows one of many such diagrams we made during the creation of the diary.

While sometimes situations emerge quickly and clearly, often this was not the case and instead the

Question	Responses (Warnings data profile)
What is the data type?	Warnings
What does the data show or communicate?	Number and details of current open warnings
Where does the data come from and/or how are they generated?	Generated internally
How are the data accessed? Are they accessed via an internal or external system?	SIADEN (internal system)
How are the data presented or visualized?	Table
Duration of visibility?	Ongoing (wall-display)
What is the velocity or refresh rate?	Ongoing/Constant
Which organisation provides the data?	Cemaden
What kind of expertise is associated with the data (or required to use it)?	All
Which activities are the data part of?	Management of Warnings
What is the geographic scale of the data?	Country

Figure 7. Data Questionnaire for SIADEN warning data. Source: Authors.

specialists would monitor data in an ongoing way, piecing things together from different sources and as part of a team discussion. In this case (Figure 8), the situation is already happening. The team of specialists are monitoring a municipality in the state of Minas Gerais. The meteorologist (Met1) has been monitoring atmospheric conditions in this region and has indicated that it has begun raining. We are shadowing the hydrologist (Hid1), who is trying to get a closer look at the region on their workstation using SALVAR (by zooming in to the municipality). While doing this, the meteorologist indicates that pluviometric data (rainfall gauges) has passed 60 mm. The hydrologist is trying to consult rain radar data, but the area of concern falls between two radars, meaning there is no radar data available. This is communicated to the meteorologist, who then indicates that there is also no pre-existing threshold in the area for rainfall (which would help determine if a warning needed to be issued). The meteorologist acknowledges that 60 mm is high, but it falls within a difficult range. This is because recent rainfall is only one relevant measure to indicate a possible risk. Accumulated rainfall, soil type, terrain, population and building density, previous disasters and other things may also need to be factored in. In this case, the hydrologist abandons the radar data and looks at accumulated rainfall (pluviometric data within the previous 24 hours), which is high. She communicates this to the meteorologist and then issues a warning without further discussion.

In this case, the situation emerges slowly, with both the meteorologist and hydrologist monitoring different sources of data in relation to a specific municipality. The 60 mm rain level prompts the meteorologist to speak and the situation intensifies. Importantly, the rainfall gauge data suggests a decision will need to be made but does not provide any certainty about the decision itself. The lack of radar data adds to the uncertainty, while the accumulated rainfall data clarifies the situation. In other cases, we observed, uncertainty would persist for extended periods and with different types of data not aligning towards a clear course of action. (There are many forms of uncertainty stemming from data, from delays in data refresh rates, to competing measures from similar data types, contrasting measures across data types, gaps in data, and measures that hover around thresholds.)

Through this sequence (Figure 8), we can see how data shapes the unfolding of the room's situation*ness*. The situation emerges slowly, with both the meteorologist and hydrologist monitoring data in relation to a specific municipality. The 60 mm rain gauge level intensifies the situation, adding certainty to its existence but little clarity in terms of what is to be done. A lack of radar data adds to the uncertainty, while the accumulated rainfall data clarifies how the situation is to be resolved. We can see very clearly from these situation sequences precisely how data intervene in situations and the decisions they call for. It is not simply that data are used to create certainty where there was none. Data create the very possibility of a situation emerging in the room; they provide the conditions for its monitoring and signals that a situation is present. Data produce both uncertainty and certainty as to the existence of a situation and the decisions that are based upon it. Once a situation is evident, data populate the space of decision-making, offering different possible ways out of the situation.

Through attention to data situations, we also see the everyday and ordinary contexts of data practices. We how specialists informally discuss their data dilemmas, how formal processes and technical systems are
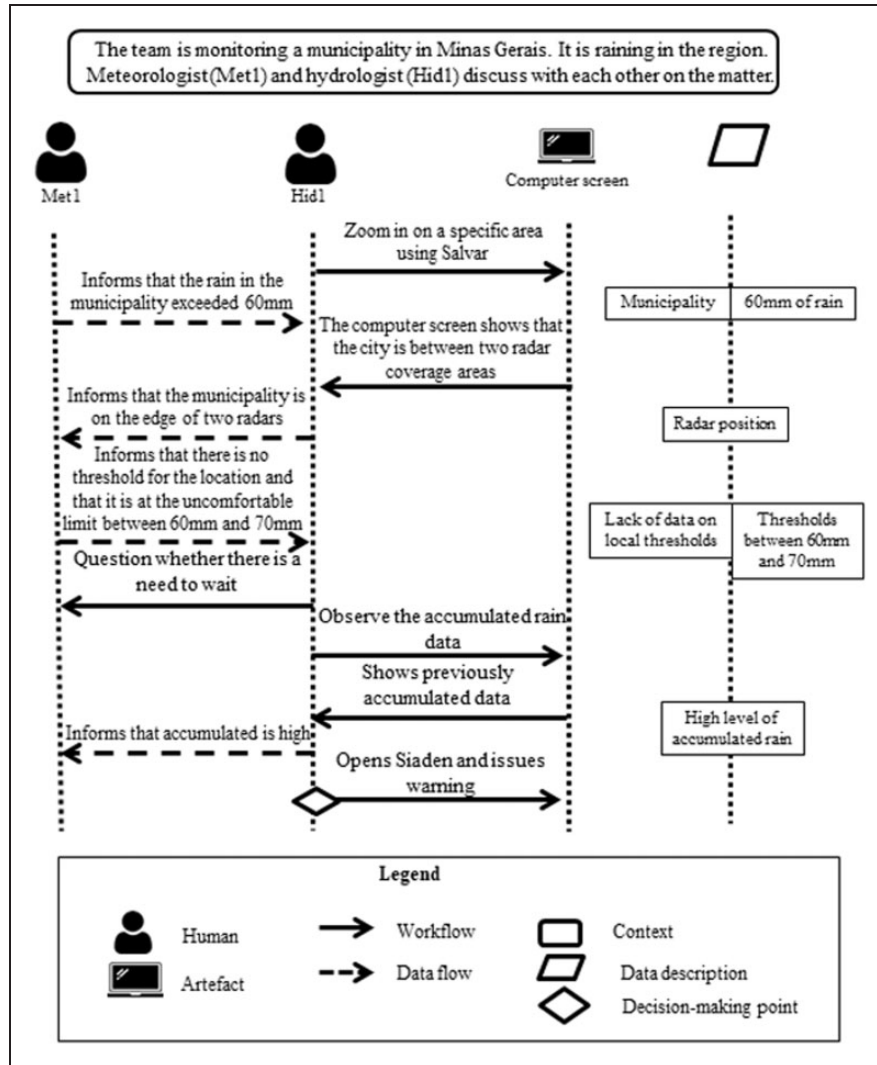
Figure 8. Sequence Diagram of a Warning. Source: Authors.

themselves transduced into conversations and processes of collaborative decision making. We observed that while data do not speak, they nevertheless have a language and set of gestures through which they achieve their interventions in specific situations. In the example above, data are spoken by the meteorologist and are embodied through the gesture of the hydrologist, who points to the accumulated pluviometric data. Sometimes the specialists are precise with their data-driven utterances, but just as often they are not, relying instead on their shared expertise and situational awareness to allow communicative abbreviations. Often, 'look', 'it's high', or 'nothing' are all that are needed for the language of data to make an intervention. The production of a data dairy is what allows us to contextualise and document such interventions in their everyday unfolding – to give a situated account of this space of data situations.

Concluding discussion: The methodological affordances of a data diary

In this article, we have suggested that the diary method can be adapted to enrich understandings of data and related data practices. We have made a case for the suitability of the diary method and detailed four points of focus – spaces, interfaces, types and situations – that informed the creation of our own diary. To be clear, our points of focus emerged in relation to the research site itself and should not be taken as necessary or inevitable. Indeed, our own study exceeded them in a number of ways, particularly in relation to questions of infrastructure and the information technology in Cemaden (but outside the situation room), which were also important in our study but were not practical to include. In addition, we have produced complimentary research in related organisational settings

connected to Cemaden. This research also informed the study and could be used as part of a larger multi-sited diary (and perhaps as part of a 'data journey'), but was left aside. This is to say a data diary is more a methodological orientation than a prescription. Attention to space, interface, type and situation enables our research team to build a general understanding of data and then gradually nuance this understanding through an account of data's situational unfolding. These points of focus were, however, not arbitrary and indeed were impressed upon us through our time in the room.

In general, the value of a method rests upon the contributions to knowledge it is able to facilitate. However, since the focus of this piece has been on the method (and not directly on knowledge), we wish to finish by outlining three ways that the data diary has helped our own research, which may also be useful for others. First, data diaries make *informality* visible. Situation rooms are system and rule-bound spaces. They are 'official' spaces. They are full of protocols and guidelines, of well-defined roles and position hierarchies, and they need to be this way. While there are many ways one might approach these qualities, we believe a useful distinction can be made between the formal and the informal, and the connotations these invoke. As 'official' spaces, the majority of discourse produced by and in relation to situation rooms is also formal in nature: operating manuals, decision-making guidelines, technical reports, and so on. Data feature centrally in much of this literature, but in well-defined and highly disciplined ways. We do not wish to refute data's formal quality. However, we do wish to make more of data's informal aspects, precisely because in spaces like situation rooms these aspects are often overlooked despite being pervasive. The idiosyncrasies of an individual workstation display; the presence of social media chat mixed in with data on the *Telão*; the tacit and experiential knowledge that allows specialists to glean a lot from a single data point, or to be suspicious despite ample data; and the myriad ways uncertainty is overcome through discussion – these are all part and parcel of the practice of data in the situation room, but unlikely to register in more formal ways of knowing. To see data as informal, is to see them in their everydayness; as participating in practices, grammars and idioms that are highly specific and resist formalisation. It is also to reaffirm well established notion that 'plans' (including rules and instructions) have their limits and can also produce uncertainty (Suchman, 2006). Given the ongoing datafication of society, and the promotion of data as central to solving any number of social and environmental challenges, given space to data's informality is pressing.

Second, despite a growing literature on the influence of data, there is a real lack of approaches that empirically document how data actually *intervenes* in a given situation. Through its points of focus, the data diary enables researchers to understand how data intervene on a number of levels, from the constitutions of the data space as such, to the configuration of the interface and the unfolding of situations. If we wish to understand how data relates to decision making, and also what kind of force it has as a social actor, it would seem paying more attention to the specific ways that data intervene is important.

Third, and finally, it is well-recognised that social science and humanities-derived ways of knowing can make valuable additions to how we understand, use and govern data. However, specifically how these ways of knowing can meaningfully contribute is, in some cases, less clear, especially since such ways of knowing often enter the scene after the fact, like a late guest at a dinner party when everything is already in motion. While the data diary does not pretend divides do not exist, its creation is a collaborative affair based on a mutual affirmation of expertise. The production of the diary is an inter- and transdisciplinary knowledge co-production endeavour (Coaffee, de Albuquerque and Pitidis, 2021), which was conducted alongside other components of a larger research project. The point was not to force anyone into seeing data in a specific way, but to produce a document that reproduces the different ways of seeing and knowing data in the situation room. As a process, the diary offers a space of cross-border knowledge creation, through ongoing dialogue and also through the presentation of the diary at various stages as a work in progress. As a product, data's informalities and the specificity of its interventions sit next to its more formal modes of representation, and these ways of knowing are able to circulate to different stakeholders beyond the situation room. It is, perhaps, a small thing. But if the humanities and social sciences are to have a voice in spaces where data and more formal knowledges rule, we need ways of making our distinct ways of knowing visible to others. More than this, though, we need ways of making our ways of knowing familiar and at home with other ways of knowing. A data diary offers a step in that direction.

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