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From extreme weather events to 'cascading vulnerabilities': participatory flood research methodologies in Brazil during Covid 19

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Abstract

Extreme weather events are entangled with each other and with other extreme events, such as the Covid-19 pandemic, anti-racist protests, drought, a housing crisis, strikes or climate emergencies, as well as with more general inadequacies due to national, economic and political upheavals and accreted vulnerabilities from long-term policies or inactions. Effects of extreme weather events are intensified by ongoing social injustices like poverty and structural racism, a housing deficit, and the consequent informal and unplanned occupation of hazardous areas, such as riverbanks, and areas of previous social-environmental disasters. In the context of Brazil, the ongoing deforestation in the Amazon (agribusiness, mining, illegal wood) provoking droughts and energy shortages in the region creates further vulnerabilities that are felt globally. In this paper, our primary contribution to these inter-connected scenarios is to describe methodological interventions that were made in response to COVID-19, and to show how those changes provided new insights into vulnerability processes of both subjects and researchers. During a larger project (*Waterproofing Data*) focused on the case study research areas of São Paulo and Acre (Brazil) wherein our wider team conducted flood-risk community research, we were forced to rethink our approach. We moved away from the singularity of the flood event and its impacts towards acknowledging the cascading conditions of social vulnerability (caused by weather, health, social and political conditions). In this paper, we directly address the 'cascade of vulnerabilities' that flood-risk communities already encounter when researchers seek to engage with them. We open new avenues to reconsider citizenship, space, and innovation in terms of the key challenges that our methods encountered when conducting participatory flood research methodologies, particularly during the first phase of the Covid19 pandemic from March 2020 to November 2021. Through flood research in Brazil, we articulate methodological contributions from the arts, humanities, and social sciences for more realistic, just, and caring research practices within and about weather in the context of 'slow violence' (Nixon 2013).

Introduction

Extreme weather events are increasing in frequency (see Hoegh-Guldberg et al. 2018). We understand them better as compound disasters and complex risk management, but less as interactions between social, cultural, environmental, political and economic processes (Kelman 2020; Hartman et al 2006). The monitoring of floods, reporting on them and the

enabling of communities to cope with them, has been researched from a citizen science and community-level planning perspective in the hope that these approaches will straight-forwardly build resilience and mitigate risk, directly addressing perceptions and behaviours (see Kuhlicke et al 2020; Sy et al 2018; McEwen et 2017; Garde-Hansen et al 2017; Adomah et al 2017; Conrad and Hilchey 2011). There is a dimensionality to resilience and De Graaf-van Dinther and Ovink (2021: 1) argue that the 'five pillars of resilience' include 'threshold capacity, coping capacity, recovery capacity, adaptive capacity and transformative capacity.' All of which becomes challenging in informal flood-prone urban communities where the 'politics of water' (Coelho and Raman 2013) and the fear of authority is greater than the fear of floods (see Choudhury et al 2016). When disenfranchised people experience everyday a lack of state assistance, welfare, insurance, or safety nets and may live in unplanned housing conditions, flooding is not a priority. Therefore, to achieve effective resilience, one that addresses social justice instead of perpetuating business as usual (Diprose 2014), we need to understand the social, material, and cultural conditions of these local communities. How is this possible when another extreme event (such as a pandemic) interrupts the researching of the extreme event (a flood) being studied?

One of the reasons for the lack of knowledge on compounded events, we argue, is methodological: the isolation of one type of extreme event from pre-existing and emergent events. Most studies focus on knowledge production on the extreme weather event. But focusing on the 'extreme' distracts from hidden, slower environmental and social injustices, for the effects of such events are distributed unevenly, disproportionally affecting the poor and disenfranchised. Focusing on the 'extreme' also distracts from understanding participatory citizenship in the context of Civil Society, subsuming government roles in managing extremes. While ultimately improving the functioning of Civil Society in this risk management context, the focus on the extreme event may only be for 'dramatic' learning rather than strategic longer-term problem solving.

Our research presented here, which undertook community engagement with flooding through data circulation, was part of the broader agenda of the *Waterproofing Data Project* (Porto de Albuquerque et al. 2021).[1] It was an ongoing co-designed and co-produced project developed with disenfranchised and socioeconomically vulnerable communities in the cities of São Paulo and Rio Branco/Acre (Brazil) that are at severe risk of flooding. From the outset the *Waterproofing Data Project* acknowledged that Global North solutions of expert and technical-centred flood risk management were not adequate for a context like Brazil. Projects such as the 'Room for the River' in The Netherlands[2] are unviable where multiple risks already exist due to dense and unplanned housing which simply cannot be readily evacuated/evicted. In Brazil there has been a lack of central government preventative action in flood risk management (FRM). Even if recently the Brazilian federal government has been consolidating its FRM and there are recent institutional improvements in the monitoring of natural phenomena and hazard events.[3]

[1] *Waterproofing Data* brought together an interdisciplinary group of researchers and institutions from three collaborating countries (UK, Brazil and Germany) in coordination with Belmont Forum's Transformations to Sustainability programme (project grant ES/S006982/1) that ran from 2018 to 2022.
[2] https://www.dutchwatersector.com/news/room-for-the-river-programme. Accessed on 20 June 2022.
[3] Note, there are challenges: (i) the inducing element of governmental responses is the occurrence of extreme events with human damage and losses capable of mobilizing public opinion (Marchezini et al, 2017) and (ii)

Therefore, the *Waterproofing Data Project* sought to give a prominent role to the process of local data collection and community resilience, as well as its connection to holistic disaster risk management as articulated in recent international development frameworks such as the 2015 Sendai Framework for Disaster Risk Reduction and the Global Partnership for Sustainable Development Data. The project adopted emerging methods, such as participatory mapping of flood risk perception and citizen-generated data into decision-making processes, to bring about transformation in the ways in which the governance of flood resilience could be conducted and made more equitable (see Petersson 2020). It developed an extended perspective on the role of data to support transformations to sustainability (Porto de Albuquerque et al. 2021). Here, data was to be used as a reference to support better decision making, and practices of generating and circulating data could themselves be opportunities for expressing hidden realities (i.e., having an expressive function); and, for developing a new critical consciousness about the phenomena to be digitised (i.e., in a metalingual function).

However, it was clear (mid-way through *Waterproofing Data* in early 2020) that the Covid 19 pandemic would interface with our methods, and this required mid-point analysis and evaluation. When the Covid 19 pandemic hit Brazil, we soon realised that flooding was entangled with this unexpected and apparently unrelated extreme event. We also realized that flooding was entangled with other extreme conditions such as ongoing poverty and structural racism, particularly in our case study research areas. These entanglements produced unexpected cascading disasters, to which our methods had to respond. In so doing, we had to adapt to the conditions of vulnerability of our participants which, although partly anticipated, played a much stronger role. Thus, the cascading disasters required a shift in focus from the studying of flooding as the 'extreme event' to the cascading vulnerabilities that traversed the communities we were working with. This paper is a response to the methodological disruption caused by the pandemic and offers an analysis of the methodological transformations and inventive methods we co-designed with local communities during the lockdowns. We suggest that some of the existing assumptions on citizen participation in flood related projects can and should be challenged, and we ask: *how does the shift of focus from extreme events to cascading vulnerabilities challenge active citizenship, the spaces where participation in flood knowledge production takes place and innovation in data collection and participation?*

Literature review: Participation under extreme conditions

Research on extreme weather events has focused on risk prevention and emergency management to reduce the physical, economic, and human costs required to 'bounce back to normal'. Yet, what makes an event extreme is a contested issue, as different parameters – intensity, frequency, damage, etc – have been used to measure it (see Cutter, 2018). The eventful condition of an extreme event has also been debated. As Hewitt (1983, 10) argued, 'even the common use of the word [disaster] "event" can reinforce the idea of a discrete

municipal governments face institutional frailty and considerable challenges in interacting with communities in situations of risk (Londe et al 2015), negatively affecting participatory citizenship and strategic problem solving.

unit in time and space' which suggests a form of discontinuity or otherness. The 'weather event' or 'natural disaster' (terms often used indistinguishably) evokes inevitability and detaches from human responsibility. The fact that disasters, weather and extreme events are broadcast live as media events distances humans even further (Dayan and Katz 1992).

All this serves to obscure the fact that many of the so-called extreme events are a 'new normal' weather within anthropogenic climate changing conditions. Therefore, can they still be considered extreme? Floods and droughts are a continuum that condition each other, where floods tend to be visible and even spectacular (highly mediated), whereas droughts are perceived as slow onset and unseen for much of their duration. This does not mean that events do not exist or that they cannot be framed, as they are, without doubt, 'eventful'. The challenge is, in our view, to place attention not on whether an event is extreme or not under the assumption that 'extreme' needs a 'rapid response', but on what hidden vulnerabilities are prepared for and responded to during the slower-moving and invisible phases of events.

From extreme events to vulnerabilities

Another challenge to extreme events is their attributed singularity. However, they are not, in fact, discrete entities, rather they trigger other disasters in what has been conceptualised as cascading events (and cascading effects). From their multiple characterisations, we draw on Pescaroli and Alexander's (2015) definition of cascading disasters and cascading effects as nonlinear processes, with multidimensional consequences that increase the impact beyond the original and mutate over time. To address this multiplicity and manage risk, Nones and Pescaroli (2016) propose to take into consideration (and model) the 'vulnerability path of cascading events'. For them, vulnerabilities emerge due to the interaction across systems: the vulnerability of the network, of society, of the interactions among environmental and human systems and vulnerability to industrial sites. This use of the concept of vulnerability associated with technical and critical infrastructures is the most prominent in the literature. But there are critical approaches too. For example, Vojinović and Abbott (2012, 5) argue:

> the development of effective flood mitigation measures requires not only sound engineering knowledge but also a much deeper understanding of social and ethical aspects, while any ignorance, either intentional or unintentional, of such aspects is likely to create not only ineffective solutions but also conditions for ever increasing risks and greater disasters.

Thus, with Vojinović and Abbott and other scholars demanding deeper and nuanced analysis of risk, disaster, and recovery, we became interested in better understanding the role and implications of human vulnerability. Here defined as the interactions of risk factors such as low educational attainment, limited income, mental illness, physical illness, or other inadequate psychological, social, or cognitive resources (Pescaroli and Alexander, 2015). Who is vulnerable? When? What happens first: human vulnerability or the disaster? Maybe what disasters do is to *highlight* accumulated and unresolved vulnerabilities in human society (Cutter, 2018); or, they might trigger trauma and remembering long forgotten but reactivate and re-vulnerabilise the community. All these questions, which suddenly came to

the fore of our research project in March 2020, did not take into consideration the temporal and spatial enactments of those vulnerabilities, nor did they take into consideration the interactions and overlaps among them. To account for them, Cutter (2018, 24) suggests not to:

> prioritize disasters by arguing that one was more damaging than the other; rather, it [seek to] understand the complexity of how disasters that happen in quick succession have a perverse multiplier effect (tipping point) on the spatial and temporal extent and nature of social existence, historical memory, damage sustained, and efforts to realize recovery.

Clearly, extreme weather events are entangled with each other and with other natural hazards (that should not be 'naturalized'), as well as other types of extreme events such as pandemic, hunger, violence, drought, a housing crisis, or climate emergency, or with the more general inadequacies and vulnerabilities noted above. The effects of extreme weather events are intensified by ongoing social crises such as poverty and structural racism, previous social-environmental disasters, and in the context of Brazil the ongoing deforestation in the Amazon (due to agribusiness, mining, illegal wood) provoking droughts and energy shortages in the southern region, including (or cascading into) Paraguay, Argentina and Uruguay.[4] In this context, the causality between event and damage is far from clear cut. Therefore, moving away from the singularity of the flood event and its impacts towards cascading conditions of social vulnerability (caused by weather, climate, health, social or political conditions) requires a person-centred approach to floods. This means to acknowledge the 'cascade of vulnerabilities' that flood-risk communities already encounter as well as the personhood of the researchers. We recognised the socio-material conditions that disproportionately affect certain groups or communities and the role of the researchers and the methodology in intensifying those vulnerabilities during Covid 19 which found the researchers newly vulnerable.

Person-centred approach to flooding

The role of civil agency is considered increasingly critical in flood risk management. Concepts such as a 'people-centred' approach or 'community-based projects' or 'retreat of the state' are common in the literature. But as Wolff (2021) argues, it is often unclear who participates and how, where and with which means, who benefits from such participation, and if participants were involved in the conceptualisation and design of the projects. It also assumes that there was a state there in the first place who has retreated, leaving flood risk to be managed by some engaging new form of community participatory decision-making, if only those communities had the knowledge to be hydrocitizens.

Borrowing the concept from the research project *Hydrocitizenship*, which explores citizens' relation to water (http://www.hydrocitizenship.com), Sarmiento, Landström and Whatmore (2019) framed the notion of hydro-citizenship as bringing democracy and participation together. In their approach, 'the prefix "hydro" signals the idea that the material, cultural,

[4] All of these inter-connected scenarios apply to our case study research areas of São Paulo and Acre (Brazil), which are examples of territories with similar characteristics.

and political-economic specificities of water make it a particularly important realm through which to study emerging understandings and practices of citizenship, democratic life, and efforts to manage human/environment relations.' (2019: 361). Exploring environmental citizenship through drought management and water governance in the United Kingdom and via Foucault's work on biopower they detected two imaginaries of hydro-citizenship. One that considers people as customers (who manage hydro resources) or as objects (that respond to management authorities). The other that considers people's affective engagements with hydrosocial spaces, where 'particular kinds of water subjects are called into being through the deployments of various techniques and technologies.' (2019: 372). The recognition of these two imaginaries and the tensions between them are useful to unpack the different modes in which knowledge and affect cut across all phases of flood resilience research projects. However, there are two challenges within the definition of hydro-citizenship. The first one is that it assumes a homogenous, Western-centred notion of 'citizen', without taking into consideration the effects of people's cascading vulnerabilities and pre-existing relationships with each other, with their territories, communities, and governments. The second relates to a generic understanding of citizenship, which is not easily translatable to a context like Brazil. The state has retreated and left large parts of the population unattended (assuming the state was ever really 'there' in the first place), increasing their intersectional vulnerabilities. Consequently, if this segment of the population feels abandoned, excluded and de-responsibilised should we not speak instead of *hydro-engagements*? How do people, traversed by cascading vulnerabilities, participate in *hydro-engagements* that involve data, recovery, and resilience? How can we adopt more dialogic modes of engagement in citizen science (Porto de Albuquerque and Almeida, 2020) towards hydro-engagements that empower critical consciousness? What would *environmental justice hydro-engagements* look like, especially if we adapt our methods to address cascading vulnerabilities?

Another question is how hydro-engagements might be organized collectively. Through a comparative study of citizen science projects for flooding resilience, McEwen *et al.*, (2018) showed how top-down and bottom-up forms of participation are not efficient for flood resilience. They observed how the lack of flood memories, health and wellbeing of the local communities, among others, affect their capacity to participate. In response they suggest a framework for building *sustainable flood memories* and groups with lower social capital through community building and social learning, to develop community capital as horizontal support. This preparation of social actors is echoed by Bujokas de Siqueira and Rothberg (2019). Working with secondary school students they recognized the role of formal education institutions (i.e., hydro-literacy) in constructing a democratic society and hydro-citizens (confirming the equation that literacy equals empowerment).

However, a report published by the World Bank in 2011 (*Case Study Overview*) highlights children and the elderly as the two collectives within the urban poor who face stronger challenges when extreme weather events occur. Kraftl (2020) argued that this is the consequence of the interrelation between infrastructures and children, where the failure of the first might create unsafety, which keeps children at home and therefore marginalised socially and economically. Together with the elderly, children are also directly vulnerable to floods due to physical harm, drowning, starvation or lack of education (Trajber *et al.*, 2019). While children are increasingly responsibilised for environmental care and the elderly are

expected to disseminate their living flood memories to the next generations, all of this is burdensome if not impossible when both collectives face cascading vulnerabilities. Interestingly, Bujokas de Siqueira and Rothberg (2019, 156) suggest that:

> hydro-citizenship can be achieved as a practice rather than a status. That means that being identified with a cause of collective interest and developing skills to access and use relevant information can be decisive in a pedagogical process comprising activities to foster the reflection on subjects such as sustainability, human rights, equality, democracy and governance.

The spaces for flood knowledge production are also relevant for participation. Kraftl et al., (2019) suggested looking at the everyday and embodied experiences of children within a nexus of energy, water and food, taking into consideration their specific political, social and technical contexts. As Kraftl notes in the opening of *After Childhood* (2020: 2) São Paulo is a particular place of multifaceted challenges that are 'knotty, intractable' where 'it is not particularly clear where one would even begin in attempting to address them.' In fact, we need to rethink how the contradictions of pandemic trauma and what Kraftl (2020: 3) sees as contradictory playfulness might de-centre trauma (and with it de-centre childhood itself) so that thinking and doing are possible *after childhood.* This means rethinking and de-centring the school itself, bringing (formal) learning into the home, and with it the tools for measuring flooding for new forms of intimate eco-pedagogies.

Digital technologies have been crucial in situations of both extreme weather events and pandemic to collect and share data, disaster reporting, scenario-ing and mitigation, to connect people and organize relief (see Assumpção *et al.*, 2018). The public can follow the narratives (of flood or pandemic) through data visualizations, graphs, tables and maps, even sharing these new forms of data among themselves. But the extended use of mobile phones or other technologies do not automatically imply participation. Pedagogical projects have focused on media education and education for sustainability, promoting what Bujokas de Siqueira and Rothberg (2019) have called digital hydro-citizenship. And yet, what happens when the digital divide is increased by one more overshadowing event (like a pandemic), or science negationism and fake news, or cultural wars fought mostly online and erupting into 'everyday life'? How does these ongoing extremes affect research methods, where interviewing, documenting, accessing and supporting are not possible because one extreme event has over-written another, one extreme event has exhausted the capacity to cope, which was already depleted?

Disrupted methodology/Emergence of hydro-engagements

The objective of the 'Community engagement through data circulation' strand of the *Waterproofing Data Project* was to co-develop methods for engaging citizens in Acre and São Paulo (Brazil) through the creation of multimodal interfaces for 'sensing' (Porto de Albuquerque and Albino de Almeida 2020), collecting and communicating flood data

(incorporating flood memories, narratives and local/lay knowledge and storytelling)[5] to stimulate flood 'curation' (Worcman and Garde-Hansen 2016; McEwen et al. 2016).

We proposed a range of innovative methods from the arts, humanities and social sciences, around data practices, across different sites and scales with civil society organizations in São Paulo and local government agencies in Rio Branco. We engaged with intergenerational groups in local communities to produce quantitative and qualitative data (which would flow back to the centres of expertise) and to document local knowledge and enable skill and knowledge transfer within the communities. Our goal was to extend what flood data can mean by illuminating experiences, myths, memories, collective knowledge, personal mediations and anecdotes of flooding and flood risk. Fundamental to this exploration was a potent collaboration between partners of the project and co-authors of this article. Based initially in CEMADEN's (National Centre for Monitoring and Early Warning of Disasters)[6] experience in Brazil (of data production and engaging communities with data co-production processes), researchers from the universities of Fundação Getulio Vargas (Brazil), Glasgow and Warwick (UK) and Heidelberg (Germany) contributed their expertise in flood memories, mapping, artistic creations and technological applications.

To address cascading vulnerabilities (infrastructural, political, etc), we focused on the cultural side, to understand the interrelations between culture, knowledge and empowerment through memory, children's education and access to social learning. We did so through personal and spatial memory work, collected through multiple technologies and in different contexts. Aware of the possible effects of flood memory research in intensifying the vulnerability conditions of our participants or their reluctance to get involved because they might be suspicious of authority (i.e. may have illegally built their property) we followed Peter and Friedland's (2017: 112) feminist ethics:

> because vulnerability is the result of many intersecting individual, social, and political factors, only an up-close knowledge of specific individuals would allow for vulnerability to be accurately determined. Indeed, it is possible that under the current paradigm for review, research ethics committees may, in their efforts to protect, unwittingly encourage stereotyping of groups, increase stigma, and undermine agency.

Therefore, instead of pre-assuming the specific vulnerabilities that traverse each of our participants, we made all activities voluntary and with the aim of empowering participants for them to cope instead of extracting their knowledge to match our stereotypes and research objectives. This approach proved open to flexing when faced with disruption.

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[5] Note that storytelling projects became important for rapid response remembering of the pandemic and can be seen in *A Journal of the Plague Year* project at https://covid-19archive.org/ as well as the collection of memories by the Museu da Pessoa, Brazil. Cultural commentators and journalists noted the lack of memorialisation of previous pandemics, and little in cultural archives of the 1917-1918 pandemic.

[6] CEMADEN has for many years carried out the monitoring of natural hazards in risk areas in municipalities susceptible to natural disasters, in particular with young people through the use of different tools (homemade rain gauge, oral history, and participatory mapping of watersheds), across Brazil. It has also conducted research and technological innovations that can contribute to the improvement of its early warning system, which include not only hard science, but also vulnerability and exposure (Marchezini *et al.* 2017).

The subsequent and unpredictable moment of change began in March 2020, with the outbreak of the Covid-19 pandemic and its spread in Brazil, followed by a teachers strike in the state of Acre that took place from May to June 2021. To begin with, this led the research team to cancel all in-person collective gatherings and activities with the team and participants. To adapt them, whenever possible, to an online format. Only at the end of 2021 did some in-person activities slowly return and only at the time of writing have we taken stock of the impact of the pandemic on the research methods. To clarify, we are aware that all research has been affected by the pandemic in one way or another and the findings of the larger *Waterproofing Data Project* are yet to be reviewed. Our aim, in what follows, is to reflect on what emerged through the adaptation process, which has provided a more nuanced understanding of the vulnerabilities accumulated within the members of our research community, the emergence of unexpected methods and what these methods have challenged. For this paper, we highlight the selected experiences below.

From rainfall crowdsourced data collection to interdisciplinary modules

The monitoring and observation of rainfall data collection through the use of artisanal rain gauges was developed in the second half of 2019 with 57 students from a public school in São Paulo (E.E. Vicente Leporace). Rainfall data was recorded on a paper sheet for three months, which was posteriorly systematised and analysed. Students were able to monitor the occurrence and intensity of the rain in the region, as well as identify risk areas and the threshold of flood (how much rain is needed for flooding in the neighbourhood?). This work was expanded through school optional modules on flood risk and data production, developed in two public schools in São Paulo (E.E Vicente Leporace and E.E. Renato Braga). The classes started regularly and as Covid-19 spread, the classes migrated to an online format. This unexpected change made evident the cascading vulnerabilities among the schoolchildren, particularly the unequal access to digital technology, which jeopardized all their learning. With the lockdown and the increased socioeconomic vulnerability of many lower income households, many students had difficulties in accessing the internet and digital devices, which led them to miss the virtual classes. In addition, a teachers strike in the state of Acre increased the disconnect and delayed the implementation of the modules. Despite students' reduced attendance, the experience of this online and collaborative optional module was praised by those who participated, contributing to engaging students in flood data production and circulation (in their home learning) and to generating new knowledge on flood risk and vulnerability in the region. The positive feedback incentivized the researchers and the partner schools to create new pedagogical material for teachers interested in conducting optional modules and activities related to Data and Disasters. The resulting Learning Guide was created during 2021 and it presents basic concepts, such as the notions of citizen science, risk, vulnerability and data, and four research tools to produce flood-related data that departs from students' own reality: participatory mapping,

oral history, artisanal rain gauges and the monitoring of local governmental data. This Guide will be linked to the *Waterproofing Data* app.[7]

From memories to documentaries

The initial memory data collection methodology was the story circle, designed by the *Museu da Pessoa*[8], a Brazilian virtual and collaborative museum of life stories, informed by the theory-practice-action methodology of Worcman and Garde-Hansen (2016). Conceived as a 'social memory technology' approach to sustainable flood memory, it was applied in the pilot and following activities in a context-specific staged design with the support of *Museu da Pessoa.* We began by asking all participants to think of two memories of floods - one that had a personal relevance and another that was memorable to their community - and to write a word representing each of these memories on two cards. In the sequence, contributors shared their memories, which were audio recorded, and put the cards in a timeline, each at a time. Normally in-person story circles are replete with resources and materials passed around members of the group. But our participants mainly talked about their memories, instead of representing them in pictures or news articles, and they did not write the story to be audio recorded due to time, levels of literacy, and barriers to sharing resources locally. We adapted the method to be more responsive to people's individual context and allowed the sharing of a sensitive issue - flooding - in a way that was safe, affective, and promoted collective recognition and identification.

To circulate the flood memories locally we organised an intergenerational event carried out in September 2019 in São Paulo, when more than 60 people - young people, adults and elderly - were exposed to and talked in person about the recorded flood memories, as well as shared new ones. This strategy was adequate, but was then challenged by the pandemic, demanding new and alternative paths for producing and circulating flood memories.

Due to the temporary impossibility of conducting new rounds of in-person flood-memory circles, the researchers decided to use digital devices to broaden the circulation of the already collected flood-memories. The strategy was to turn some of the existing flood memories into short videos to be disseminated online. This required new and higher-quality recordings of people's memories, which were made in Oct-Dec 2020 and in Sept-Oct 2021. This sub-project was named *Waterproofing Memories* and resulted in 30 short videos disseminated in the *Waterproofing Data Project's* Youtube channel. Even though the production of these short documentaries was done by professionals, not by citizens, they

[7] In fact, a new project was created 'WPD++ Waterproofing data citizen science: pollination of a mobile app in communities', for the development, deployment and evaluation in an educational perspective of a mobile application, a community-based intervention and the production of education materials. This builds upon the results of Waterproofing Data and relating to the baseline Theory of Change and Logic Model co-created at the project on-set in order to monitor achievements and track impacts. The material will be available online and at no cost from 2022 onwards in the *Cemaden Educação*'s website, and it can be used for in-person or online activities at schools throughout Brazil.

[8] A story circle, where participants bring to the workshop their own memories of flooding in the area: news articles, photos, stories, anecdotes, myths passed down in the family. In the second part the participants benchmark their 'flood knowledge' through memory work by crafting a 250-word story to be audio recorded and edited alongside 1-3 photos to create a 1-2 minute digital story. https://museudapessoa.org/

have valued citizens' memories and contributed to the expanding of these memory circulations. They have been extensively used in several activities of the project, including meetings with authorities and activities with the partner schools.[9]

Distributed artistic interventions in public spaces to cultural centres

Artistic installations in public spaces were planned to be developed in São Paulo and Rio Branco in 2020 to return some of the data and findings co-created by citizens and the centres of expertise. Due to the lockdowns and the temporary closure of collective gathering spaces, such as cultural centres, parishes and schools during the pandemic, they were postponed several times.[10] The uncertainty of what might be possible, where and when at the different stages of the pandemic required a continuous re-conceptualisation of the artistic installation, with whom it could be co-designed and where it could be installed. Due to the time and budget constraints of *Waterproofing Data*, the research team designed a flexible system that could be activated, produced, and installed with different budgets and by multiple and diverse communities, who could then produce their own output and express what mattered for them with regards to flooding. A team of curators and designers was hired in São Paulo to take over the project and make it theirs. Five exhibitions have been materialised so far.[11]

Emergent methods

Other methods had to be co-designed in the process that involved (due to lockdown) a re-centring of the school and de-centring of childhood as the place where flood learning could emerge in pandemic conditions in the intimacy of the home environment and through playful methods. These methods were necessarily inventive and interdisciplinary (Lury and Wakeford 2012). Here we focus on two: the Memories Contest and the Dignified Parcel of Food.

Based on the work with flood memory developed virtually with school children and teachers from the two public schools in 2020, we carried out an online Flood Memory Contest

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[9] See 'O buraco na parede / A hole in the wall' (https://www.youtube.com/watch?v=fvZvRB9lUQY) or 'Da enchente à reciclagem/From flood to recycling' (https://www.youtube.com/watch?v=mqibcpTkOIc).

[10] This postponement was a small example of the much greater loss of the arts, artistic practice, in-person exhibition visits and performances seen across the world and in Brazil in particular. Something vital was missing from society: carnivals, festivals, theatre and the solidarity and compassion that accompanies these cultural events. The pandemic brought to the surface the hidden cultural labour of many freelance artists and precariously employed cultural workers and so our postponement of the artistic engagement with hydro-citizenship underscored the importance of the arts for flood risk management.

11 Between May and June 2022 (at the time of writing), five adaptations took place between Acre (University of Acre, Autonomists Memorial), São Paulo (M'Boi Mirim Culture House and church, FGV), and a sixth one is being planned in Glasgow, UK. The curators were Barbara Alves de Souza, Matheus de Oliveira Santos and Felipe Magalhães dos Santos and approximately 200 visitors had viewed the exhibition. The photographs were taken by Lucas Lourenço and Juliana Bombrim, videos by Juliana Bombrim, graphic design by Yan Peixoto Marques and Wellison Bezerra, the producers were Iasmin Castro, Jennifer Andrade and Mário Henrique da Mata Martins. A long list of local people contributed to the exhibition and post-lockdown were enthusiastic to ensure its impact, which shall be evaluated in forthcoming publications.

(something fun or even silly one might say - referring to Kraftl 2020 above - in the context of all the pandemic trauma) with four public schools in the two cities. This Contest took place from August to November 2021 with a twofold goal: to incentivize student engagement with flood memories in their communities, encouraging them to become young community reporters, and to produce additional material for the postponed artistic installations. Students could send their productions in the format of pictures or interviews. In this process, we organized two live sessions with the students.[12] The Contest was interdisciplinary, involving teachers from various disciplines, who got excited about the activity and adapted it to their own curricula, with different submission formats. It involved 126 students and resulted in the production of more than 40 pieces, mostly short videos.

It is important to reiterate here that our methodology was adapted because 'the environmental risk space' widened suddenly to include a novel virus. Thus, when our research sought to explore with young people, teachers and local communities the fundamental question of whether they felt threatened by the environment around them or whether there are environmental threats where they live (and here originally we had 'floods' in mind) those questions now drew compound responses because 'the environment' now contained an invisible and unmanageable threat which had no precedent in living memory. Our participants were locked down and as such also needed food, since many had their livelihoods disrupted by mobility restrictions and other impacts of the pandemic. With an increase in extreme events worldwide, we realized (as researchers also feeling threatened by the virus in our own communities) that we could not hand out leaflets or send weblinks to resources without providing real assistance to our research participants. Hence, we decided to halt our research and fundraise to send 'dignified food parcels'. This emerged method was not developed to demonstrate care (albeit it surely did) but it was just the only possible thing to do, as under conditions of extreme events the material conditions of participants and researchers cannot be disregarded.

Discussion: Reflections on citizenship, spaces and innovation in the *Waterproofing Data Project* during Covid 19

Extreme weather risk, climate changes and inequalities are moving, invisible and slowly unfolding events: memories of each overlap and entangle and are reactivated. Researchers can contribute to 'slow violence' if they insist on their distance and objectivity or privilege their original methodology in such times of cascading vulnerabilities. Therefore, we had to transform and create new methods to address the structural inequalities the pandemic and our flood risk research were making visible. Such methods were necessarily 'intensive excursions' and 'interventional as well as observational' because suddenly the trauma of remembering flood events was entangled with the trauma of the pandemic, and so we delved into questions that revealed 'what matters to people' in the context of cascading environmental disasters (Pink and Morgan 2013, 352).

12 See online: Launching of the Contest: https://www.youtube.com/watch?v=8R4Ud2EobBs&t=29s Dialogue on Audiovisual production: https://www.youtube.com/watch?v=8R4Ud2EobBs&t=29s

Public participation and co-design were affected by cascading conditions of social and political vulnerability and marginalisation. Who can participate, who can be active, and how, during a pandemic? Should the research team reorganise their priorities, methods and outputs of the project? The pandemic shifted the initial role distribution among young adults and the elderly in memory knowledge sharing. The lockdowns led to the isolation of the elderly, whilst schools played an important role in keeping connected the young people - the ones unaffected by the digital divide. The research team had to come up with activities like the short-videos or the contest where the young people were the mediators with the elderly. This led to students interviewing their relatives and neighbours, becoming the flood memory storytellers. The interviews became joyous moments of family and neighbourhood history discoveries, activating an intergenerational sharing of stories that had not been told because of trauma or shame. This resulted in young adults' social empowerment through knowledge transfer, discovery, joy and healing, as a form of *environmental justice hydro-engagements.* Teachers became empowered too for they owned the Memories Contest call (acting on behalf of researchers who were not able to travel), adapted it to their interests and collaborated across modules and grades. Although these adapted activities were successful in terms of impact, they have also become a challenge for the research team. The entries were made in different formats, thus complicating the design of the art installation and showing the tensions that emerge from different degrees of openness in co-design.

The lockdowns also drastically affected the spaces where hydro-citizenship usually happens. From institutional collective spaces (like churches, schools, squares) to a few homes. What challenges does this pose to researchers when flooding requires evacuation, yet pandemic requires staying at home, even if those 'homes' are so precariously positioned or without a safety net? The shift to the domestic highlighted the cascading vulnerabilities that traversed them (lack of food, light, internet access), which reduced exponentially the capacity of people to invest in flood research. This required the re-prioritization of the project's objectives to put the food parcels and social justice first. For participants, the idea of resilience shifted towards a sense of consciousness and criticism of their own vulnerability, of an unsustainable social, political, economic, environmental system, and the possibility of transformations towards sustainability. But the split between collective and domestic spaces was more complex. Schools became spaces where cascading vulnerabilities could be placed at a temporary emotional/real distance while schools themselves sought to create spaces of co-production and compassion. The generation and circulation of data created new data/spaces (Tkacz et al. 2021) which defined digital geographies with new spatialities, constituting new spaces that congregated young people and elderly in exchanges of flood memories, whilst at the same time, excluded others.

The overlapping of cascading vulnerabilities led to an important methodological shift: *cascading methods*. We planned to co-design with young adults the physical and digital tools for learning how to measure flooding events and flood risk, but we also had to cascade methods and approaches (sometimes from a distance), of how to conduct, record, and edit interviews, how to communicate quantitative and qualitative digital and analogue data through audio-visual means and the differences between research and fake news. The research team had to pass on some of their research techniques to the students, who engaged in recording digital flood memories through these new skills. It is important to point out that the aim of this paper is not to claim successful adaptations of a participatory

research project (Ritterbusch 2019) but to acknowledge that the methodological shifts described above were tentative and precarious for everyone involved.

The cascading vulnerabilities the pandemic revealed clearly entangled personal, collective and professional lives in ways that could not be disassociated, which intensified the emotional labour and time spent for each decision or activity. Regardless of our efforts, the overlap of the two events (flood and Covid19) and the cascading vulnerabilities disrupted the relationships and reciprocal learning that were being nurtured, making participation and co-design even more fragile, incomplete and an imperfect process. Our attempt has been to identify some learnings and openings to expand the tools, people, and places where reciprocal learning and participation in environmental issues can take place. Even if we understand that the moments of empowerment, participation and engagement were contextual and possibly temporary, we have also celebrated them to account for the learning experiences, exciting moments, synergies and new forms of care which took place that we never anticipated when embarking on the research.

Conclusion

In the *Waterproofing Data Project* we expected data to have an expressive function (Porto de Albuquerque et al. 2021), to be metalingual, quantitative, questioning and telling stories. In the context of flood risk management, data can have two ways/modes: responsibility and advocacy. But it also has a third way: it reveals hidden and unseen vulnerabilities and it can form a collective identity, as data communities are created while data is being collected (infection rates, extreme weather events, citizen science groups etc). Circulations of data are also circulations of care and compassion, feelings and imagined communities. Data production is a way of increasing critical consciousness of flooding but also of the complexity of flooding and pandemic as socio-technical interfaces. The outbreak of Covid 19 in Brazil during 2020 produced data that had stories and memories of environmental risk embedded in pandemic and other traumas, wherein delayed destructions and disruptions happened all at once, involving everyone in one way or another. Our original methodology promoted participation, responsibility and resilience among two flood risk communities in Brazil during 2019-2022. Right in the middle of that project the coronavirus rapidly spread and in our case study areas a teachers' strike was compounded by lockdowns, food insecurity and unemployment. In general literature on resilience, we find responsibility is assigned to the community (see Kaika 2017) but how can this community be responsibilised for flood risk management when a pandemic reveals and amplifies so starkly all the compounded vulnerabilities? From a participatory way of doing research, the solutions and resilience require an engagement with the people living there and a new responsibilisation of the researchers. For more realistic, just and caring research practices within and about floods as well as slow violence.

Our research (while not fully complete and yet replete with meanings) has explored the changing role of Civil Society in the Extreme Weather Adaptation Cycle in the context of environmental injustice and uneven risk management. We did not simply navigate and negotiate the implications of the dichotomies (extreme versus everyday) but we folded them into the project in solidarity with our research participants. We did not reveal the

tensions between theory and practice in how the communities prepare for, and recover from, both mundane events and extreme weather risks. We expanded our imaginations on what old and new harms circulate within and around flood risk areas in order to reframe cascading disasters as already spreading vulnerabilities. Alexander and Pescaroli (2019: 5) argue that 'disaster tends to "pick off" the least able in society. This should be a powerful moral argument for revitalising the concept and practice of welfare, and making it proof against complex cascading impacts' (our emphasis). To *waterproof data* is far more than preserving or ensuring the data processes and apparatuses are more protected against water-related extreme events. Rather, waterproofing data entails ensuring that the processes of researching and calculating flood risk are themselves practices of care, welfare and acts of re-existence in the face of weakening community support mechanisms.

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