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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 the more general inadequacies due to national, economic and political upheavals and accredited 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 risky areas, such as river banks, previous social-environmental disasters, and in the context of Brazil the ongoing deforestation in the Amazon (agribusiness, mining, illegal wood) provoking droughts and energy shortages in the region. All of these interconnected scenarios apply to our case study research areas of Sao Paulo and Acre (Brazil), in which we analysed examples of territories with similar characteristics in terms of socioeconomic and environmental vulnerability and recurrence of floods, wherein we conducted flood-risk community research during 2019-2021. Moving away from the singularity of the flood event and its impacts towards cascading conditions of social vulnerability (caused by weather, health, social or political conditions) must recognise a people-centred approach to floods. It must acknowledge a ‘cascade of vulnerabilities’ that flood-risk communities already encounter. In this article, we open new avenues to reconsider citizenship, space and innovation in terms of the key challenges that our project - Waterproofing Data - 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 ‘social violence’ (Nixon 2013). We ask: what would *environmental justice hydroengagements* look like where public participation is risky?

Introduction

Extreme weather events are more and more frequent (see Hoegh-Guldberg et al. 2018) and we understand them better, not only as compound disasters and complex risk management, but as not entirely unexpected 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 al 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.’ However, all this becomes challenging in informal flood-prone urban communities where the ‘politics of water’ (Coelho and Raman 2013) or where fear of authority is greater than fear of floods (see Choudhury et al 2016). Our communities were just such places (particular to the Global South) wherein disenfranchised people experience everyday a lack of state assistance, welfare, insurance or safety nets, and may live in unplanned housing conditions.

In this context, the emergence of Covid19 (during the early months of 2020 when we were undertaking our research) qualifies as an extreme event that when compounded with other natural and man-made hazards produces cascading disaster. Yet, focusing on the ‘extreme’ distracts from hidden, slower environmental injustices: the effects of such events are distributed unevenly, disproportionately affecting the poor and disenfranchised. If researchers do focus on extreme flood events then they must acknowledge the lived experience of extant extremity for those specific communities (how and when and in what ways is a ‘flood’ defined and described as normal, expected, tolerated, extreme in these circumstances?). Local stories of trauma, recovery etc may become obfuscated or ignored if centres of expertise are only focused on data and its veracity or actionability under certain conditions.

Focusing on the ‘extreme’ also distracts from understanding participatory citizenship in the context of Civil Society subsuming government roles in managing extreme weather events. 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 problem solving, particularly in Brazil where there may have been historically a lack of central government response to flood risk management (FRM). Even if recently the Brazilian federal government has been consolidating its FRM and there have been recent institutional improvements in the monitoring of natural phenomena and hazard events, 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 (Marchezine et al, 2017) and (ii) 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.

The research presented here is part of the broader project [Waterproofing Data](#),¹ an ongoing co-designed and co-produced project developed with disenfranchised and socioeconomically vulnerable local communities in Brazil that are at severe risk of flooding.

¹ Waterproofing Data brought together an interdisciplinary group of researchers and institutions from the 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 2021.

In this Waterproofing Data Project we adopted emerging methods, such as participatory mapping of flood risk perception and citizen-generated data into decision-making processes and began to bring about transformation in the ways in which the governance of flood resilience is conducted and made more equitable (see Petersson 2020). The project gives 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 such as the 2015 Sendai Framework for Disaster Risk Reduction and the Global Partnership for Sustainable Development Data. The research acknowledged that Global North solutions of expert/technical-centred flood risk management solutions such as the ‘Room for the River’ project in The Netherlands are not possible to roll out in Brazilian cities where multiple risks already exist due to dense and unplanned housing which simply cannot be readily evacuated/evicted. Therefore, in order to understand the compound risks and vulnerabilities better, this chapter reflects on the methods and findings of the unfinished research on ‘Community engagement through data circulation’ which was undertaken during the Covid19 pandemic in 2020 and 2021. 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 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).

Therefore, our research combined a number of humanities and social science methods for engaging citizens 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).² Our methods have brought citizens (their place memories of flooding) and science (the geo-localisation of flooding knowledge) together in new ways for rethinking the relation and passages between cultural and scientific types of knowledge (Garde-Hansen et al. 2017). We have engaged with intergenerational groups in local communities not only to produce quantitative and qualitative data (which will flow back to the centres of expertise) but also to document local knowledge and enable skill/knowledge transfer within the communities. This section of the project therefore includes intergenerational methods of knowledge production based on several methods and approaches with the goal of extending what flood data can mean by illuminating experiences, myths, memories, collective knowledge, personal mediations and anecdotes of flooding and flood risk. In this context, co-produced knowledge processes highlight the variety and richness of tacit flood knowledge and help generate new types of flood-related data for the use and reflection of the affected communities and other stakeholders, as well as more complex ways of engaging with flooding events that defy the victimhood or empowerment dichotomies through what we have called *environmental justice hydro-engagements*.

As noted earlier, during the development of the project the novel coronavirus pandemic emerged and everyone, including the researchers, tried to adapt. What we soon realised was that flooding is entangled with other extreme events: a pandemic, ongoing poverty,

² 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 in particular.

structural racism and so on, particularly in our case study research areas of Sao Paulo and Acre, Brazil. Thus, our methods had to adapt to the research of the flooding events entangled with the other extreme events. For the purposes of this article the research team reflected on the following questions.

- A) Which other extreme events were interlaced with flooding events at the time of research?
- B) How does the shift of focus from extreme events to cascading vulnerabilities challenge active citizenship?
 - B1) How is participation and co-design affected by cascading conditions of social vulnerability?
 - B2) Who can participate, who can be active, and how has this required us to reorganize the priorities, methods and outputs of the project?
- C) How does the shift of focus from extreme events to cascading vulnerabilities challenge the spaces where participation in flood knowledge production takes place?
 - C1) What are the ways in which people have continued (or not) engaging with flooding during the pandemic taking into consideration lockdowns and collective gatherings?
 - C2) What challenges does this pose to researchers?
- D) How does the shift of focus from extreme events to cascading vulnerabilities challenge innovation in data collection and participation? Digital technologies have been crucial in situations of extreme weather events to collect and share data, connect people, organize, etc.
 - D1) But what happens when the digital divide is increased by another event (like the pandemic), or citizens do not have the capacity to connect more?
 - D2) How does this affect research methods, where interviewing, documenting, accessing and supporting are not possible because of another event?

Literature review

Research on extreme weather events has focused on risk prevention and emergency management, to reduce the physical, economic and human costs required to 'go back to normal'. Considerable research has elaborated on what makes an event extreme. This is a contested issue, as there are different parameters that can be taken to measure it – intensity, frequency, damage, etc (see Cutter, 2018). The notion of the calamitous event has also been under discussion. As Hewitt (1983, 10) argued, 'even the common use of the word [disaster] "event" can reinforce the idea of a discrete unit in time and space' which suggests a form of discontinuity or otherness'. Even the notion of 'disasters are nonroutine social problems' while emphasising 'the social' does assume that 'collective stress situations' will occur quickly, abruptly and visibly (Kreps and Drabek 1996: 130). It could also be argued that a 'weather event' or 'natural disaster' evokes inevitability and detaches human responsibility and the 'media event' (Dayan and Katz 1992) connotes scripting and performance. The fact that disasters, weather and extreme events are also broadcast live as media events distances humans even further. All this serves to obscure the fact that many of the so-called extreme weather events are the 'new normal' weather within

anthropogenic climate changing conditions. Flood and drought are a continuum that condition each other (and yet drought is slow and unseen for much of its onset). 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 focus on whether an event is extreme or not, and can extreme only ever be seen and rapidly responded to, or is it also slow onset, invisible and requiring careful responses?

It has been widely recognized that weather events or disasters are not discrete entities. They trigger other disasters, and therefore can be conceptualised as cascading events. 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. As a consequence, Nones and Pescaroli (2016) propose to take into consideration the modelling of the 'vulnerability path of cascading events', where vulnerabilities emerge due to the interaction across systems: the vulnerability of the network, of society and of the interactions among environmental and human systems and vulnerability to industrial sites. Importantly, the use of the concept of vulnerability associated with technical and critical infrastructures is common in the literature. 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, like other scholars demanding deeper and nuanced analysis of risk, disaster and recovery, we are interested in better understanding the role and implications of human vulnerability. (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), 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). Or may extreme events trigger trauma and remembering long forgotten but reactivated and re-vulnerabilising the community. All these ideas, although eventually useful for modelling, do not take into consideration the temporal and spatial enactments of those vulnerabilities, nor do they take into consideration the interactions and overlaps among them. To account for these differences Cutter suggests the notion of 'social cascades', which 'do not prioritize disasters by arguing that one was more damaging than the other; rather, it seeks 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.' (Cutter, 2018, 24).

Clearly, extreme weather events are entangled with each other and with other extreme events and natural hazards (that should not be 'naturalized') such as pandemic, hunger, violence, anti racist protests, drought, a housing crisis or the climate emergency, or with the more general inadequacies and vulnerabilities noted above. Effects of extreme weather

events are intensified by ongoing social crises like 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 the southern region, including (or cascading into) Paraguai, Argentina and Uruguay. 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, wherein we conducted flood-risk community research during 2020 and 2021. In this context, the causality between event and damage is far from clear cut. 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) must recognise a people-centred approach to floods. It must acknowledge a ‘cascade of vulnerabilities’ that flood-risk communities already encounter. In particular, the socio-material conditions that disproportionately affect certain groups or communities because of their intersectional conditions of social vulnerability.

Within all the approaches to address cascading vulnerabilities (infrastructural, political, etc), our project has looked at the cultural side, to understand the interrelations between culture, knowledge and empowerment through memory, children’s education and access to social learning. And we have done 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 (ie may have illegally built their property) we have 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 them to cope instead of extracting their knowledge to match our stereotypes.

The overlapping of extreme events like flooding and a health pandemic in the Brazilian context of our research presented three key challenges this article will cover.

1) The challenge of active (hydro) citizenship in a context where citizenship is itself so precarious. The role of civil agency is considered increasingly critical in flood risk management. Concepts like ‘people-centered’ approach or ‘community-based projects’ or ‘retreat of the state’ are common in the literature, but as Wolff (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 exciting 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 to bring democracy and participation together. In their approach, the prefix 'hydro' signals the idea that the material, cultural, 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 England 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, and another one 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 flooding resilience projects. Sarmiento et al mobilize the notion of hydro-citizenship to explore how people are governed in and through water, asking: 'Might there be some way to facilitate self-conduct in a way that is more than self-interested?' (2019: 372). However, for our case study there are two challenges with this definition. The first one is that it assumes a homogenous and generic 'citizen', without taking into consideration the effects of people's cascading vulnerabilities. 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 every really 'there' in the first place), increasing their intersectional vulnerabilities. As a consequence, this segment of the population feels excluded and de-responsibilized. So, could we speak instead about *hydro-engagements*? How do people, traversed by cascading vulnerabilities, participate in *hydro-engagements* that involve data, recovery and resilience? What would *environmental justice hydro-engagements* look like?

Through a comparative study of citizen science projects for flooding resilience, McEwen *et al.*, (2018) show how top-down and bottom-up forms of participation are not efficient for flood resilience. They observe 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. The preparation of social actors is echoed by Bujokas de Siqueira and Rothberg (2019). Working with secondary school students they recognize the role of formal education institutions (ie hydro literacy) in constructing a democratic society and hydro-citizens (confirming the equation that literacy equals empowerment). Interestingly, they 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. (Bujokas de Siqueira and Rothberg, 2019: 156)

However, a report published by the World Bank in 2011 (*Case Study Overview*) highlights two collectives within the urban poor who face stronger challenges when extreme weather events occur: children and the elderly. Kraftl (2020) argues 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). However, while children are increasingly responsabilised 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 if both collectives face cascading vulnerabilities.

In our analysis below we explore how public participation and co-design are affected by such 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 the priorities, methods and outputs of the project?

2) The challenge of the spaces for flood knowledge for co-production. Kraftl *et al.*, (2019) suggest 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. Within children's distributed geographies of flooding, we address the spaces in which people have continued (or not) engaging with flood memories during the pandemic taking into account lockdowns and prohibition of in-person collective gatherings. 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 insurance? Our research has engaged with schools as spaces where cascading vulnerabilities can be placed at a temporary emotional/real distance while schools themselves seek to create spaces of co-production and compassion. This does not ignore the complex challenges that children, in particular, faced during the pandemic in our two case study areas. 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.' One place we chose was the space of learning between teachers and children, the space of fun and competition, wherein we invited both to look again at the environment, to 'look again at how children are positioned within' the complex challenges of pandemic and flood. To think again about how the contradictions of pandemic trauma and what Kraftl (2020: 3) sees as the contradictory silliness or playfulness might de-centre trauma (and with it decenter childhood itself) so that thinking and doing are possible *after childhood*. This means rethinking and decentering the school itself, bringing learning into the home, and with it the tools for measuring flooding itself as new forms of intimate flood pedagogies.

3) The challenge of innovation where resources are scarce, everyday life is disrupted and communities are experiencing shock/trauma. Here we accept that 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 (Assumpção *et al.*, 2018). The public is able to follow the narratives of flood and 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 technological apparatus 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. In our project we have enacted this approach through 'the circulation and sharing of views and memories on historical experiences about mechanisms of social, economic and political inclusion in a democratic society' and like Bujokas de Siqueira and Rothberg we 'considered this as a productive way forward, given the particular Brazilian political setting, where the creation of river basin management committees has become a fundamental step in the articulation between public authorities and society in the environmental field' (2019: 157). In the Waterproofing Data Project we have developed these pedagogical approaches *with* young people 'to enable participants and researchers to co-construct 'theorisations' of food, energy and water as a nexus of essential resources constituting their everyday lives.' (Trajber et al., 2019, p. 91). However, 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 occasionally erupting into 'everyday life'? Do citizens have the capacity to connect and understand complexity more than they already are or can access? How does this 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?

Methodology

In this article we are interested in unpacking how thinking about extreme weather events in terms of cascading vulnerabilities might challenge research and researchers, and how these challenges might rethink notions of citizenship, space and innovation in flood related participatory projects. We will do so by reflecting on the changes to our initial methodology that we had to implement to adapt to the rapidly altering conditions brought about by the coronavirus pandemic during 2020/2021 and the conditions of vulnerability of our participants which, although anticipated, played a much stronger role.

To explore 'Community engagement through data circulation' in two cities in Brazil we proposed a range of innovative methods from the arts, humanities and social sciences, which are necessarily inventive and interdisciplinary (Lury and Wakeford 2012) around data practices, across different sites and scales. 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)³ experience in Brazil (of data production and engaging communities with data co-production processes) we added the expertise in flood memories, mapping, artistic creations and technological applications by scholars from the universities of Warwick and Heidelberg.

³ 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 objective was to develop methods for engaging citizens through the creation of multi-modal interfaces for sensing, collecting and communicating of flood data (incorporating flood memories, narratives and local knowledges) to stimulate flood 'curation' (Worcman and Garde-Hansen 2016; McEwen et al. 2016) and to bring together an intergenerational group to produce not only data, but also knowledge and skill transfer through the communities. To achieve this, we proposed personal and spatial memories data collection, which would flow back to the centres of expertise, and to co-design a material-medial artistic intervention to return to the participants and their communities the outputs of the whole project Waterproofing Data.

The Anticipated methods:

- a) Observation and data collection of rainfall through crowdsourcing. Participatory monitoring of the occurrence - or not - of rains, with the analysis of the periods of intensity, and of the rainfall distribution in the territory formed by the observational network of the school.
- b) 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.
- c) A picture walk to conduct a visual ethnography with intergenerational participants. To register the traces of floods that they remember, but also the ones they might not. It will involve conversations about how to look in detail at the physical environment and to think about it from a science and technologies studies perspective: as a socio-technical assemblage composed by buildings, plants, people, water, history, etc.
- d) Artistic installation in a public space to return to some of the data and findings co-created by citizens and the centres of expertise.

The Actual methods.

The subsequent and unpredictable moment of change began in March 2020, with the outbreak of the Covid-19 pandemic and its spread in Brazil. To begin with, this led the research team to cancel all in-person collective gatherings and activities and to adapt them, whenever possible, to an online format. Only at the end of 2021 did some in-person activities slowly return, and so only now have we taken stock of the impact of the pandemic on the research methods, and these have required:

- a) Adapting the observation of data collection of rainfall through crowdsourcing.

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 table on a paper sheet for

three months and it was posteriorly systematised and analysed. Students were able to monitor the occurrence and intensity of the rain in the region, as well as to identify the risk areas and the threshold of flood (how much rain is needed for flooding in which parts of the neighbourhood?). This work was planned to be expanded to three other public schools in 2020, as part of an elective discipline on flood risk to be developed in partnership with teachers, however it was halted due to the lockdown and interruption of in-person classes.

- b) Description of memories data collection conducted and challenges and adaptation through the different vulnerabilities and extreme events.

The original methodology was adapted in collaboration with the *Museu da Pessoa*⁴, a Brazilian virtual and collaborative museum of life stories, who had worked collaboratively with Worcman and Garde-Hansen (2016) on a 'social memory technology' approach to sustainable flood memory. With their support, in the pilot and following activities, we applied the method of flood memory circles, structured in a context-specific staged design. 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 storycircles 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, barriers to sharing resources locally). The adapted method was 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. It also meant that when the pandemic came we had a low resource and engaging method at work that could adapt more easily.

In view of the positive feedback and people's rising interest in the flood memories, we had developed a collective gathering to present and debate the memories. This intergenerational event was carried out in September 2019 in São Paulo, when more than 60 people - young people, adults and elderly - were exposed to and talked about the recorded flood memories, as well as shared new ones. This strategy seemed adequate to circulate the flood memories locally, but it was then challenged by the pandemic, demanding new and alternative paths for producing and circulating flood memories, which will be presented in the next subsection.

- c) The picture walk to conduct a visual ethnography with intergenerational participants.

An initial pilot was conducted at the Kick-off meeting in June 2019 in Brazil. The area was decided jointly by the researchers and local partners (civil society organizations in São Paulo and local government agencies in Rio Branco). A few of the neighbours of the areas we visited showed us the materials and places where traces of flooding were inscribed in their own houses, and which people use to measure, predict or remember flooding events.

⁴ <https://museudapessoa.org/>

Although participants were meant to be taking the pictures and mapping the locations, this was not possible this time due to pandemic restrictions. The luxury of showing us these places in 2019 seemed such a distant possibility by 2020 where now the most vulnerable could not isolate if they needed to make money, where isolation may not be possible in a large family or small rooms, and where hygiene and hand-washing had now taken on such significance for already stretched families.

d) The Artistic installation

The artistic installations were planned to be developed in São Paulo and Rio Branco in 2020. However, due to the lockdown and the temporary closure of collective gathering spaces, such as cultural centres, parishes and schools during the pandemic, they were postponed several times. 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.

The artistic installations are currently planned to take place in the first semester of 2022, considering the high vaccination rates in Brazil and the gradual return of in-person activities and collective events. However, 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 iteration at the time of writing focuses on designing a flexible system and a process that can be activated, produced and installed with different budgets and by multiple and diverse communities, which can produce their own output and express what matters for them in regards to flooding.

The Innovative Methods

However, other methods emerged in the process that re-centred the school and de-centred childhood as the place where flood learning could emerge in pandemic conditions.

1) The school optional module

In 2020, school optional modules on flood risk and data production were 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 that took place from May to June 2021 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 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 a 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 is will also be linked to the Waterproofing Data app (in development at time of writing). 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.

- 2) Short-documentaries on flood memory, which are being displayed on youtube. they can contribute to the circulation of these citizens memories (even though their production was done by professionals, not by citizens)

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 has been named Waterproofing Memories and it will result in 30 short-videos to be disseminated in the Waterproofing Data Project's Youtube channel. Part of these memories have already been re-recorded and transformed into short-videos with subtitles in English. Even though the production of these short-documentaries have been done by professionals, not by citizens, they have valued citizens' memories and contributed to the expanding of these memories circulation. They have been extensively used in several activities of the project, including meetings with authorities and activities with our partner schools.⁵

- 3) Memories contest: Interdisciplinary teachers from all disciplines engaged in the call.

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

⁵ See 'O buraco na parede / A hole in the wall' (<https://www.youtube.com/watch?v=fvZvRB9IUQY>) or 'Da enchente à reciclagem/From flood to recycling' (<https://www.youtube.com/watch?v=mqibcpTkOic>).

process, we organized two live sessions with the students, which can be seen in the following links:

- 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>.

The Contest was interdisciplinary, involving teachers from various disciplines, who got excited with the activity and adapted it to their own curricula, requiring different submission formats. It involved 126 students and resulted in the production of more than 40 pieces, most of them short videos. The ownership of the call by the teachers, although successful in terms of impact, has become a challenge for the research team. As the entries are in different formats it complicates the design of the art installation, showing the tension of different degrees of openness of a co-design process.

- 4) The dignified parcel of food as a reminder of preparedness for participants and researchers

It is important to note here that our methodology adapted because 'the environmental risk space' widened suddenly to include a novel virus. So 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 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. Hence, we connected as researchers (also under threat) with our participants and decided to halt our research and fundraise to send 'dignified food parcels' as a form of solidarity. Our participants were locked down and as such needed food. With an increase in extreme events worldwide, we cannot only hand out leaflets or weblinks to resources when providing assistance to research participants. The structures of our methodology were not set in stone, they were adaptable and the structural inequalities the pandemic and our flood risk research were making visible could not be ignored. Extreme weather risk, climate changes and inequalities are slow moving, invisible, slowly unfolding events (see Nixon 2013) but researchers contribute to 'slow violence' if they insist on their distance and objectivity in such times of cascading vulnerabilities.

Reflections on Citizenship, Spaces and Innovation in the Waterproofing Data Project during Covid 19

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 young adults -the ones unaffected by the digital divide. Therefore, the research team had to come up with activities like the short-videos or the contest where the young adults were the mediators with the elderly. This led to students interviewing their relatives and neighbours, becoming the flooding memories storytellers. But not only. The interviews became joyous moments of family and neighbourhood histories' 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*.

The lockdowns also drastically affected the spaces where hydro-citizenship usually happens. From institutional collective spaces (like churches, schools, squares), to a few homes. 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-priorization of the project's objectives to put through the food parcels, 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 transformation towards sustainability.

The overlapping of cascading vulnerabilities led to another methodological shift: from co-designing with young adults physical and digital tools to learn how to measure flooding events, to learning how to conduct, record, and edit interviews, how to communicate quantitative and qualitative data through audiovisual 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 flooding memories through these new skills.

Despite these challenges Waterproofing Data⁶ research has continued and developed a new mobile application, which aims to support local governments, flood-prone communities and schools in the production and circulation of rain- and flood-related data to improve flood resilience. Based in citizen science crowdsourcing.

Conclusion

In the Waterproofing Data project we expected data to have an expressive function, to be metalingual, quantitative, questioning and telling stories. Data can have two ways/modes in the context of flood risk management: responsibility and advocacy. But it also has a third way: it creates awareness, 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 also 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

⁶ 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.

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 responsabilised for flood risk management when a pandemic reveals so starkly all the compounded vulnerabilities? From a participatory way of doing research, the solutions and resilience have to come with an engagement with the people living there. For more realistic, just and caring research practices within and about floods as well as social 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 protecting or ensuring the data processes and apparatuses are more resilient to extreme events: it is to ensure the processes of researching and the calculating of flood risk are themselves practices of welfare and acts of resistance to the systematic weakening of community support mechanisms.

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References

Adomah Bempah, S. and A. Olav Øyhus (2017) 'The Role of Social Perception in Disaster Risk Reduction: Beliefs, Perception, and Attitudes Regarding Flood Disasters in Communities along the Volta River, Ghana'. *International Journal of Disaster Risk Reduction* 23 (August): 104–8.

- Alexander, D and G. Pescaroli** (2019) What are cascading disasters?. *UCLOE*. Vol. 1, 1-6.
- Assumpção, T.H. et al.** (2018) 'Citizen observations contributing to flood modelling: opportunities and challenges', *Hydrology and Earth System Sciences*, 22(2), pp. 1473–1489
- Bujokas de Siqueira, A. and Rothberg, D.** (2019) *Hydro-citizenship and media education: using multimodal content production to engage young people in water management*. MILID Yearbook 2018/2019. UNITWIN, UNESCO, Autonomous University of Barcelona, Arab Academy of Science, Technology and Maritime Transport, pp. 151–162.
- Coelho, K. and N. V. Raman.** (2013) 'From the Frying Pan to the Floodplain: Negotiating Land, Water, and Fire in Chennai's Development'. In *Ecologies of Urbanism in India: Metropolitan Civility and Sustainability*, edited by Anne Rademacher and K. Sivaramakrishnan. Hong Kong: Hong Kong University Press.
- Choudhury, Mahed-Ul-Islam, and C. Emdad Haque.** (2016) "'We Are More Scared of the Power Elites than the Floods": Adaptive Capacity and Resilience of Wetland Community to Flash Flood Disasters in Bangladesh'. *International Journal of Disaster Risk Reduction* 19 (October): 145–58.
- Conrad, C. and K. Hilchey.** 2011. 'A Review of Citizen Science and Community-Based Environmental Monitoring: Issues and Opportunities'. *Environmental Monitoring and Assessment* 176 (1–4): 273–91.
- Cutter, S.L.** (2018) 'Compound, Cascading, or Complex Disasters: What's in a Name?', *Environment: Science and Policy for Sustainable Development*, 60:6, 16-25
- Dayan, D and E Katz** (1992) *Media Events: Live Broadcasting of History: The Live Broadcasting of History* (Cambridge, MA: Harvard UP).
- Garde-Hansen, J, L McEwen, A Holmes, and O Jones.** 2017. 'Sustainable Flood Memory: Remembering as Resilience'. *Memory Studies* 10 (4): 384–405.
- Graaf-van Dinther, Rutger de, and Henk Ovink.** 2021. 'The Five Pillars of Climate Resilience'. In *Climate Resilient Urban Areas*, edited by Rutger de Graaf-van Dinther, 1–19. *Palgrave Studies in Climate Resilient Societies*. Springer International Publishing.
- Hartman, Chester, and Gregory D. Squires,** eds. 2006. *There Is No Such Thing as a Natural Disaster: Race, Class, and Hurricane Katrina*. Hoboken: Routledge.
- Hewitt, K.** (1983) *Interpretations of Calamity*, Boston: Allen and Unwin
- Hoegh-Guldberg, O., D. Jacob, M B. S. Brown, I Camilloni, A Diedhiou, R Djalante, K Ebi, F Engelbrecht, and J Guiot.** 2018. 'Impacts of 1.5 C Global Warming on Natural and Human Systems'. *Global Warming of 1.5° C. An IPCC Special Report*. https://report.ipcc.ch/sr15/pdf/sr15_chapter3.pdf.
- Kaika, M.** (2017). 'Don't call me resilient again!': the New Urban Agenda as immunology ... or ... what happens when communities refuse to be vaccinated with 'smart cities' and indicators. *Environment and Urbanization*, 29(1), 89–102.
- Kelman, Ilan.** 2020. *Disaster by Choice : How Our Actions Turn Natural Hazards into Catastrophes*. United States: Oxford University Press
- Kraftl, P. et al.** (2019) '(Re)thinking (re)connection: Young people, "natures" and the water–energy–food nexus in São Paulo State, Brazil', *Transactions of the Institute of British Geographers*, 44(2), pp. 299–314
- Kraftl, P.** (2020) *After Childhood: Re-thinking Environment, Materiality and Media in Children's Lives*. London: Routledge
- Kreps, G.A. and Drabek, T.E.** (1996), 'Disasters are nonroutine social problems', *International Journal of Mass Emergencies and Disasters*, 14: 2, pp. 129-153

- Kuhlicke, C., S. Seebauer, P. Hudson, C. Begg, P. Bubeck, C. Dittmer, T. Grothmann.** 2020. 'The Behavioral Turn in Flood Risk Management, Its Assumptions and Potential Implications'. *WIREs Water* 7 (3).
- Marchezini, V. et al.** (2017a) 'Participatory Early Warning Systems: Youth, Citizen Science, and Intergenerational Dialogues on Disaster Risk Reduction in Brazil', *International Journal of Disaster Risk Science*, 8(4), pp. 390–401
- Marchezini, et al.** (2017b) 'Sistema de alerta de risco de desastres no Brasil: Desafios à redução da vulnerabilidade institucional' in Marchezini, V. Wisner, B., Londe, L.R. & Saito, S.M. (Eds.), *Reduction of vulnerability to disasters: from knowledge to action* São Carlos: Rima Editora, pp.287–310
- Londe, L.R.; Soriano, E.; Coutinho, M.P.** Capacidades das instituições municipais de Proteção e Defesa Civil no Brasil: desafios e perspectivas. *Revista do Departamento de Geografia*, 2015, v.30, p.77-95
- McEwen, L. A. Holmes, N. Quinn and P. Cobbing** (2018) "Learning for resilience": Developing community capital through flood action groups in urban flood risk settings with lower social capital', *International Journal of Disaster Risk Reduction*, 27, pp. 329–342
- McEwen, L., J. Garde-Hansen, A. Holmes, O. Jones, and F. Krause.** 2017. 'Sustainable Flood Memories, Lay Knowledges and the Development of Community Resilience to Future Flood Risk'. *Transactions of the Institute of British Geographers* 42 (1): 14–28.
- Nixon, R.** (2013) *Slow Violence and the Environmentalism of the Poor* (Cambridge, MA: Harvard UP)
- Nones & Pescaroli** (2016) 'Implications of cascading effects for the EU Floods Directive' *International Journal of River Basin Management*. 14. 195-204.
- Pescaroli and Alexander** (2015) 'A definition of cascading disasters and cascading effects: going beyond the "toppling dominos" metaphor' *Planet@Risk Glob Forum Davos* 3(1):58–67
- Peter, E. and J. Friedland,** (2017). Recognizing Risk and Vulnerability in Research Ethics: Imagining the "What Ifs?". *Journal of Empirical Research on Human Research Ethics*. 12:2, 107-116
- Petersson, Louise.** 2020. 'Community Mapping Supports Comprehensive Urban Flood Modeling for Flood Risk Management in a Data-Scarce Environment'. *Frontiers in Earth Science* 8: 15.
- Pink, S. and J.Morgan.** 2013. 'Short-Term Ethnography: Intense Routes to Knowing'. *Symbolic Interaction* 36 (3): 351–61.
- Porto de Albuquerque, J., and A. Albino de Almeida.** 2020. 'Modes of Engagement: Reframing "Sensing" and Data Generation in Citizen Science for Empowering Relationships'. In *Toxic Truths*, edited by Thom Davies and Alice Mah. Manchester University Press.
- Sarmiento, E., Landström, C. and Whatmore, S.** (2019) 'Biopolitics, discipline, and hydro-citizenship: Drought management and water governance in England', *Transactions of the Institute of British Geographers*, 44(2), pp. 361–375
- Sy, Bocar, Corine Frischknecht, Hy Dao, David Consuegra, and Gregory Giuliani.** 2018. 'Flood Hazard Assessment and the Role of Citizen Science'. *Journal of Flood Risk Management*, 14.
- Trajber, R. et al.** (2019) 'Promoting climate change transformation with young people in Brazil: participatory action research through a looping approach', *Action Research*, 17(1), pp. 87–107
- Vojinović, Z., and M. B. Abbott.** 2012. *Flood Risk and Social Justice: From Quantitative to Qualitative Flood Risk Assessment and Mitigation*. London, UK: IWA Publishing.

Wolff, E. (2021) 'The promise of a "people-centred" approach to floods: Types of participation in the global literature of citizen science and community-based flood risk reduction in the context of the Sendai Framework', *Progress in Disaster Science*, 10, p. 100-171

Worcman, K and J. Garde-Hansen (2016) *Social Memory Technology: Theory, Practice, Action*, New York: Routledge