



Climate-U

Transforming Universities
for a Changing Climate

Empowering young students in climate justice: the design, implementation and outcomes of a 'Climate Detective' toolkit

**Transforming Universities
for a Changing Climate
Working Paper Series No. 21**

Sylmara Lopes Francelino Gonçalves Dias
Ana Beatriz Nestlehner Cardoso de Almeida
Amanda Cseh
Isabela Cavaco
Aline Gomes

December 2023



**UK Research
and Innovation**



Climate-U

Transforming Universities
for a Changing Climate

Empowering young students in climate justice: the design, implementation and outcomes of a 'Climate Detective' toolkit

Transforming Universities for a Changing Climate Working Paper Series, No. 21

December 2023

www.climate-uni.com

Tweet @ClimateUniv

© December 2023 Climate-U,
Institute of Education, UCL
20 Bedford Way, London, WC1H 0AL

Free to download with use of suggested citation:
Dias, S., de Almeida, A., Cseh, A., Cavaco, I. and Gomes,
A. (2023) *Empowering young students in climate justice:
the design, implementation and outcomes of a 'Climate
Detective' toolkit*. Transforming Universities for a
Changing Climate, Working Paper Series No. 21

ISSN: 2754-0308

Contact:

Professor Sylmara Lopes Francelino Gonçalves Dias
sgdias@usp.br

Authors

This working paper was coordinated by lead writers Professor Sylmara Lopes Francelino Gonçalves Dias, Ana Beatriz Nestlehner Cardoso de Almeida, Amanda Cseh, Isabela Cavaco and Aline Gomes. It was a collaborative effort by Climate-U University of São Paulo (USP) Brazil team: Sylmara Lopes Francelino Gonçalves Dias, Ana Beatriz Nestlehner Cardoso de Almeida, Amanda Cseh, Isabela Cavaco, Aline Gomes, Luciana Ziglio, Pedro Henrique Campello Torres, Caio Vanucci and Lucas Araujo.

Sylmara Lopes Francelino Gonçalves Dias is coordinator for the Climate-U project and Associate Professor at the University of São Paulo (USP). Professor Dias is leader of the research centre of Organizations, Society and Sustainability. She has a PhD in Administration from the Getulio Vargas Foundation and a PhD in Environmental Science Multidisciplinary Programme from the University of São Paulo. She has experience in sustainability, integrated solid waste management, waste pickers, recycling, climate change and climate justice.

Ana Beatriz Nestlehner Cardoso de Almeida is Research Associate at Climate-U, and currently is part of the Centres of Organization, Society and Sustainability Research Centre and the Nucleus of Landscape Studies at the University of São Paulo (USP). She is an architect and urbanist and Msc student in Landscape and Society Studies of the Faculty of Architecture and Urbanism and Design of USP. She also attended the international master's programme "Spatial Planning for Regions in Growth Economies" at TU Dortmund and UP Diliman. Her research focuses on sustainability, children's rights, public policies, landscape studies and climate change, with a particular focus on participatory methodologies.

Amanda Cseh is a Climate-U Research Associate at the University of São Paulo and is a member of the research centre of Organizations, Society and Sustainability. She has a Master of Science in Sustainability from the School of Arts, Sciences and Humanities at the University of São Paulo. She has a bachelor's degree in environmental management from the University of São Paulo. Her interests include integrated organic waste management, selective collection, sustainability, environmental management, climate change, and climate justice.

Isabela Carmo Cavaco was a Research Associate on the Climate-U project at the University of São Paulo (USP).



Isabela is a master's student of Environmental Science at the Institute of Energy and Environment (IEE-USP), where she studies climate justice. She has a bachelor's degree in environmental management at the School of Arts, Sciences and Humanities (EACH-USP) and she has been working and researching climate change since 2019, in between internships and undergraduate research projects.

Aline Gomes is a Fellow on the Climate-U project at the University of São Paulo (USP). Aline is a volunteer at Cursinho Popular EACH. She is an undergraduate student in Environmental Management in the School of Arts, Sciences and Humanities at USP.

Luciana Ziglio is a geography teacher, postgraduate student, and researcher at the FLACSO-Brazil. She is currently a postdoctoral researcher at the IAG/IEE/USPSusten, University of São Paulo. She is interested in interdisciplinary research with environmental questions and theories about political issues.

Pedro Henrique Campello Torres is co-coordinator on the Climate-U project at the University of São Paulo (USP). Professor Torres is a social scientist and urban planner. He is currently a postdoctoral researcher at the Institute of Energy and Environment at the University of São Paulo. He was previously a Professor of Environmental Management for an undergraduate course at USP. He is interested in interdisciplinary research in urban and regional planning and urban and environmental sociology, primarily on the topics of environmental inequalities, environmental and climate justice, urban planning and policies in cities and metropolises.

Caio Henrique Kameyama Vannucci was a Fellow on the Climate-U project at the University of São Paulo (USP). He is an undergraduate student in Environmental Management in the School of Arts, Sciences and Humanities at USP.

Lucas Tiago Araujo de Carvalho was a Fellow on the Climate-U project at the University of São Paulo (USP). He is an undergraduate student in Environmental Management in the School of Arts, Sciences and Humanities at USP.

Abstract

The impacts of climate change hit hardest the most vulnerable populations across all global territories. Studies have demonstrated that climate change disproportionately exposes children and adolescents to multiple risks. Considering the school as the epicentre of social change in its territory, we designed participatory action research (PAR) and citizen science in a middle/high school in Ribeira Valley, São Paulo State, Brazil. The aim of this working paper is to present the methodological design process, implementation, and outcomes of the development of a toolkit for climate justice education. To achieve this aim, the research explored how dialogical and meaningful learning can contribute to climate justice education so as to: support students' understanding of their territorial vulnerability and spatial inequalities; enhance scientific knowledge co-creation about climate justice; empower students to act for climate justice; and promote citizenship practices. The main outcomes were the Climate Detective toolkit co-creation, taking the territory as framework; raising awareness of how vulnerabilities are amplified by extreme climate events; filling information gaps with data collected by students; and empowering students through citizen science.

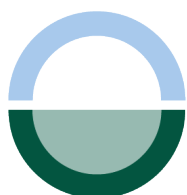


Table of contents

Abstract	3
1. Introduction	5
2. A Framework of Climate Justice Education	6
3. Contextual and Territorial Vulnerability Overview	10
4. Climate Detective Toolkit development and implementation	12
5. Climate Justice Education: Dialoguing with Teaching-Learning and Empowerment of Students and Teachers	17
6. Lessons from the Case Study	18
7. Final Remarks	19
Acknowledgements	20
References	21
Appendix	23



1. Introduction

The impacts of climate change hit hardest the most vulnerable populations across all global territories¹. Furthermore, it is at the local scale where the materiality of these grievances is felt and the challenges of the ability to react and adapt to extreme weather and climate events are seen. In a society with extreme social inequalities, it is essential to understand that the impacts of climate change are also unequal and can be more pronounced for populations in conditions of high vulnerability (Gonçalves-Dias and Cseh, 2021). The lack of critical infrastructure² (i.e. electricity, drinking water, sanitation, internet, among others), poor spatial connectivity, and poor access to public services and amenities contribute to social vulnerability as they are determining factors for exposure to environmental risks (WHO, 2019; UNICEF, 2021). Natural hazards gain notoriety from the media and public administrators when significant human populations are affected (Roggero, Ziglio and Miranda 2018); the increasing prevalence of these hazards due to climate change enlarges the impact on populations, while exposure to risks exacerbates the social gap and impairs the ability of vulnerable communities to adapt.

In this scenario, vulnerable communities are more susceptible to the climate injustices that already affect our planet. The literature constructs the differences of adverse socio-environmental and economic effects as a matter of climate justice. Studies highlight that there is no single concept for climate justice and that diverse collective actions can address different understandings for the term (Campello-Torres, Leonel, Araújo, 2020; Martinez-Alier et al., 2018; Sultana, 2021). Climate justice fundamentally is about paying attention to how climate change impacts people differently, unevenly, and disproportionately, as well as redressing the resultant injustices in fair and equitable ways (Sultana 2022). Social movements defend the fight for climate justice as a way to combat inequalities and denounce false solutions that end up perpetuating privileges instead of fighting them (Sultana, 2021, 2022; Campello-Torres, Leonel, Araújo, 2020). In this way, we seek to understand how the resilience of local populations can improve national and local policies for climate action from a bottom-up perspective (Schipper et al. 2014), as well as reinforcing participatory mechanisms' importance, in addition to formal participation (Trajber et al 2019).

Our programme "Education for Climate Justice" takes as a starting point some of the theoretical considerations presented in 'A Protocol for Participatory Action Research into Climate Justice:

1 Territory in this study is "the place of life" (Sauer and Almeida 2014, 418). As the place of life, the territory is a "created thing" - or "a space of historical demands for the recognition of cultures that have the territory as a reference" (Acsegrad 2013, 6-7).

2 According to UNDRR terminologies, critical infrastructure includes the physical structures, facilities, networks, and other assets which provide services that are essential to the social and economic functioning of a community or society (UNDRR, n.d.)

3 MDV is the anonymity code used for the school. This school serves middle and high school students from the district of Itapeúna and the rural neighbourhoods, in which habitat and economic factors drive different conditions of vulnerability and risk exposition related to climate change.

4 *Quilombolas* are Black communities remaining from colonial slavery and legally set as "traditional peoples and communities", which are defined in Brazilian legislation as "culturally differentiated groups that recognize themselves as such, that have their own forms of social organisation, that occupy and use territories and natural resources as a condition for their cultural, social, religious, ancestral and economic reproduction, using knowledge, innovations and practices generated and transmitted by tradition." (Brasil, 2007)

Principles and Tools' (Frediani and Nussey, 2021), and draws from 'Climate Injustice in Brazil: What We Are Failing Towards a Just Transition in a Climate Emergency Scenario?' (Campello-Torres, Leonel and Araújo, 2020), 'Critical Climate Justice' (Sultana, 2021), three UNICEF reports (2015, 2021, 2018) which highlight the need to focus on child-responsive and inclusive spatial development, as well as Freire's (1996, 2000, 2008) work on education for transformation, and meaningful learning by Ausubel (2000).

Working on a local scale is recognizing the impossibility of a ready-made recipe that works for all territories worldwide. The heterogeneous aspect of these spaces and the imperative construction – or rather, co-construction – of shared knowledge with the residents, is necessary through what is conventionally called a 'bottom-up' process (Schipper et al. 2014). In this sense, we will explore the complexity of these themes, considering the territory as reference (Ascerald, 2013).

This working paper is based on an extended case study (Burawoy, 1998; Burawoy, Burton, et al., 1991): a public state school 'MDV'³, located in the district of Itapeúna, Eldorado Municipality, Ribeira Valley region, in the state of São Paulo. Ribeira Valley basin comprises part of both the states of São Paulo and Paraná and is a hotspot in Brazil regarding the Atlantic Forest, natural resources, and biodiversity conservation (IPBES, 2019). Nevertheless, the socioeconomic vulnerabilities of Eldorado are evident in the low wages, poor infrastructure quality and insufficient public services (SEADE, 2023). Eldorado is also strongly impacted by rains, floods, and hosts ancestral lands for indigenous communities and *quilombola*⁴ communities, which present enormous social, economic, and territorial vulnerabilities.

The focus of this working paper is the development of a toolkit for climate justice education, presenting its methodological design process, implementation, and outcomes. This objective was permanently anchored in the dialogical and meaningful learning approach, highlighting potentialities and paths in constructing more resilient communities. To reach the goal, the research questions were:

How can dialogical and meaningful learning contribute to climate justice education to:

1. Support students' understanding of their territorial vulnerability and spatial inequalities?
2. Enhance scientific knowledge co-creation about climate justice?

3. Empower students to act for climate justice?
4. Promote citizenship practices?

In a climate emergency scenario, where constant changes in the political, economic, and socio-environmental dynamics affect students' realities, teaching-learning methods and techniques are necessary to support students to acquire and articulate their knowledge in an interdisciplinary way (Nussey, 2021). They are based on the perception of a complex world, demanding that knowledge is no longer seen in a static way. Therefore, new learning environments are needed to provide 'interdisciplinary knowledge, intuition and creativity' and to allow transcending disciplinary and conceptual boundaries. This approach is called meaningful learning (Ausubel, 2000; Moreira, 2012) and differs from the traditional educational paradigm, which is based on mechanistic logic and distances itself from reality.

For Burawoy (1998), it is necessary to develop reflective proposals of science capable of breaking the positivist epistemological principles and promoting dialogue between social scientists and the people studied. In this perspective, knowledge production is materialised from the interaction of the 'stock of academic theory' with 'popular theory or endogenous narratives' in local realities. This dimension considers that multiple dialogues and explanations of empirical phenomena between observer and participants lead to a second dialogue between local processes and extra-local forces, which in turn can only be understood through a third level: "dialogue of theory with itself" (Burawoy, 1998, p5).

Thus, in the following section, we first introduce concepts and approaches of climate justice, as well as connecting the subject to potentials of meaningful learning and citizen science, such as pedagogical strategies to promote youth and children's protagonism, especially the ones living in a local context crosscut by several vulnerabilities. We also present our conceptual base of territory as a key reference for the construction of our educational tool. Then we show the methodological path used for the collection and analysis of the case study of the MDV School, its respective school community, and the analysis unit. Thereafter, the findings are presented and discussed. Finally, we present the conclusions and some remarks about this study.

2. A Framework of Climate Justice Education

Climate justice education is a powerful tool to engage and mobilise society for critical thinking, increasing its capacity for a broad analysis of reality, building resilience, and ensuring participation and co-responsibility in transforming local reality (Marchezini et al., 2020; Trajber et al., 2019). From an interdisciplinary approach, this study adopts climate justice as a response of vulnerable communities due to the disproportionate local impact in facing extreme climatic and meteorological phenomena. Therefore, we assume that resilient territories must be guided by community co-

construction and collective mobilisation in the struggles for better living conditions.

UNICEF (2015) emphasises how children and adolescents are disproportionately exposed to multiple risks due to climate change. They are the most impacted, especially those in vulnerability (UNICEF, 2015). Including children and adolescents in discussions on climate adaptation in their territory and empowering them with critical thinking is strategic to enhance their resilience⁵, their adaptability to climate change and to improve citizenship. Moreover, they have high capacity to change community behaviour, due to their high communication and engagement skills (Seballos et al., 2011; Trajber et al., 2019; UNICEF, 2015; UNICEF, 2021). Thus, investing in children is critical, urgent, and strategic to an inclusive development of resilient and climate-responsive communities to achieve social and territorial equity. Therefore, it is a fundamental instrument for empowering children and adolescents in promoting climate action that seeks to fight against social and territorial injustices.

However, in Brazil educators and public policymakers still lack the knowledge to include the topic in the political agenda and educational guidelines. This highlights the need to review and adapt educational programmes and curricula, so that students develop skills and attitudes to prevent and adapt to unequivocal and imminent climate impacts (UNESCO, 2019). Developing a national educational framework and free access tools is fundamental, as Nussey highlights:

"[...] developing curricula to support the integration of climate change into schools and universities, fostering positive change and ensuring that these toolkits are open access, [...], are useful first steps." (Nussey, 2021, p17)

In this context, the Climate-U project *Transforming Universities for a Changing Climate* allowed engaging stakeholders around our main research programme 'Education for Climate Justice', which included several participatory virtual and face-to-face activities to engage local communities, students, teachers, undergraduate students, professors and local government. The Climate Detective toolkit offers a series of participatory activities based on dialogue education (Freire, 1996, 2000), meaningful learning principles (Ausubel, 2000) and citizen science approaches (Dickinson et al., 2012; Cavalier and Kennedy, 2016). These approaches are each characterised by a cyclical process of participation. List (2006) and De Toledo and Giatti (2014) argue that social mobilization, trust, and reciprocity between researchers and subjects need to value the degree of commitment of the network's processes and relationships with each other. So, a higher level of engagement would empower subjects and make them proactive, giving them the power to better solve their problems.

Through dialogical education (Freire 2000), we look to value all individual experience, knowledge, and cultural context, thus promoting the ability to read reality and act to transform it, imbuing

⁵ The ability of social, economic, and environmental systems to recover or reorganise from natural disasters in a way that maintains their essential functions, identity, structure, and capacity to adapt, learn and transform (IPCC, 2022).



everyday life with meaning (Freire, 1993, 2000). Understanding the locality and "reading of the world"⁶ (Freire, 1993, 32), is crucial for raising consciousness levels (see Table 1 below) and bringing new challenges for people's emancipation (Freire, 2000) by enhancing their perception of reality.

Activity	Date
Semi-intransitive consciousness	The individual is so immersed in her/his reality that s/he cannot take distance for a more critical reading of its reality.
Total adherence with objective reality	The person feels incapable of problem-solving, which is understood as "fate or destiny", and the solutions are delegated to a "higher power". There is no possibility of change, and her/his action has a "defensive magic" character.
Naive Transitive Consciousness	People have an enlarged perception capacity. Still, they feel unable to change reality, so they find external culprits for their problems (politicians, bosses, relatives or other villains)
Critical awareness	The individual overcomes the transitive-ingenuous consciousness by means of praxis, that is, s/he learns from the reflection of the results of her/his actions (action-reflection-action).

Table 1. Description of the three levels of human consciousness, according to Friere. Based on Friere (2000).

Knowledge production requires dialogicity. In this sense, we drew on meaningful learning (Ausubel, 2000) as a strategy to deal with the challenge of critical thinking about climate, in which symbolically expressed ideas interact in a substantive and non-arbitrary way with what the learner already knows. Moreira (2012, p12) reiterates that "meaningful learning is characterised by the interaction between prior knowledge and new knowledge", and that this interaction is "non-literal and non-arbitrary". In this process, new knowledge acquires meaning for the subject and the previous knowledge acquires new meanings or greater cognitive stability (see Figure 1).

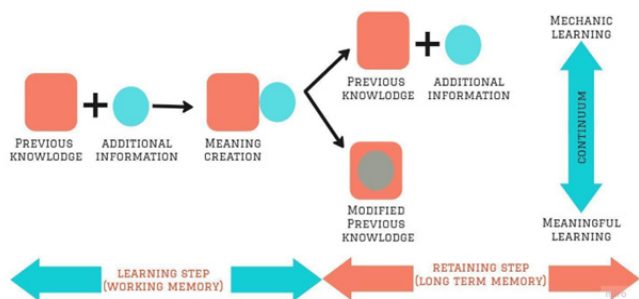


Figure 1. Mechanical learning versus meaningful learning. Based on Ausubel's theory (2000).

In summary, we adopted two conditions of meaningful learning (Table 2) to orient the development of our educational strategy.

Conditions for meaningful learning	Description
1) The learning material must be potentially meaningful.	It implies that: 1.1 The material (books, lessons, applications, ...) has logical meaning (i.e., is relatable in a non-arbitrary and non-literal way to an appropriate and relevant cognitive structure), and 1.2 The material must be relatable to the cognitive structure and the learner must have the necessary prior knowledge to make this relationship in a non-arbitrary and non-literal way.
2) The learner must have a predisposition to learn.	2.1 The learner must have predisposition to learn. 2.2 Subject that learns must be predisposed to interactively relate (differentiate and integrate) the new knowledge to her/his previous cognitive structure, giving meaning to this knowledge. 2.3 It may avoid mechanical learning and engage participation.

Table 2. The two conditions of meaningful learning. Based on Moreira, 2012 (p8-9).

In the current study, this teaching-learning strategy was strengthened by activities based on the citizen science proposal. Therefore, it allowed the young students to link their previous knowledge to scientific knowledge alongside the experiences of the population affected by climate change. The citizen science approaches have relevant environmental or public policy implications (Dickinson et al., 2012), and increase the student capacity to respond to climate change. Regarding the school as the epicentre of social transformation in its territories, we introduced participatory action research (PAR) methodology, in which dialogue education and meaningful learning were key teaching strategies to promote the protagonism of children and adolescents.

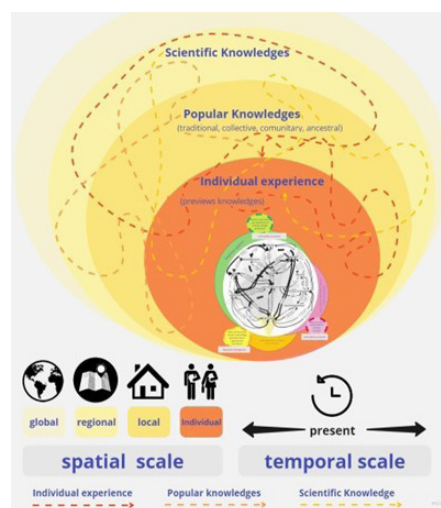


Figure 2. Articulation among prior, popular, and scientific knowledge as pedagogical strategy of the Climate Detective toolkit. Based on Freire (1993, 1996, 2000, 2008); Ausubel (2000); Dickinson et al. (2012).

6 The "reading of the world" is understood here as the "reading" that precedes the reading of the word and that, pursuing equally the understanding of the object, takes place in the domain of everyday life (Freire, 1993:32).

In this context, our participatory research was shaped by means of interactive and continuous processes, requiring constant reflection and methodological adaptation, because of the requirement to legitimise a dialogue-based engagement between the subjects involved, enabling them to take control of the process itself, as well as to contribute with their own anxieties, questions, motivations, and criticisms. The praxis is understood here as transforming action, i.e., a dialectical union between theory and practice. Therefore, it demanded a supportive, dialectical, dialogical, creative, and critical movement. In this sense, our proposal agenda was framed in the spatial and temporal relationship about climate perception through past, present, and future, as shown in Figure 2 (above).

Our educational activities included citizen science projects strategies (Cavalier and Kennedy, 2016) as defined by the United States Environmental Protection Agency (EPA):

1. **Strengthening communities** by fostering citizens, especially those historically marginalised, to act in data collection, processing, analyses, project development and its implementation.
2. **Establishing continuous monitoring strategies** by promoting a comprehensive data collection, where national agencies are not able to perform.
3. **Extending research for key problems** according to local specificities that are not normally covered by governmental agencies, promoting public participation for both knowledge production and decision-making procedures.
4. **Educating citizens on environmental and climate issues** through experience, such as meaningful learning and dialogical education.

For the conception of education for climate justice in this study, it is also essential to discuss two central concepts: vulnerabilities and territory. Vulnerability is configured as a central element in the risk equation (Oliveira, 2018), and it can be approached as a result and context, mediated by a process of complementarity between them (Iwama et al., 2016). However, it requires an interdisciplinary analysis considering that vulnerability always happens in each territory with a combination of biophysical and socioeconomic characteristics, among others. In this sense, vulnerability was a key concern in this study, considering the territory as a reference (Ascerald, 2013).

Vulnerability, from technical studies, is understood as the susceptibility to which a population is exposed to suffer damage; as the relationship between the intensity of damage caused and the magnitude of a threat; and as the probability of a population or region being affected by a dangerous process that turns into a disaster (DECS, 2020). In broad terms, vulnerability is:

"[...] the central question of the risk equation. A reflection of the physical conditions of the environment, the social, political, and economic conditions, both individual and collective, of a given community." (Oliveira, 2018, p2)

Once the social experience of risk is not confined to the technical definition of risk, that is, the product of probability and magnitude,

we considered as well how students perceive a threat to their well-being and how their evaluation of probabilities and magnitudes of unwanted consequences is also associated with psychological, symbolic, and cultural factors, such as beliefs, attitudes and experiences that interfere in individual and collective actions for mitigation and adaptation to climate events (Renn, 2011). Within this discussion, risk perception was referred to the association of knowledge and feelings when faced with a situation that implies adverse consequences (Kasperson et al., 1988). The perception of risks increases according to access to information, the individual's experience, location, and proximity to risks, influencing vulnerability and adaptive capacity to events.

Our study aimed to be an integrative and interdisciplinary approach to achieve a heuristic understanding of vulnerabilities (Cutter, 2011; Oliveira et al., 2020) in order to deepen the comprehension that vulnerable populations are not just those who are at risk due to their exposition to dangers, but because they are immersed in social processes of marginalisation, and thus live in a "permanent emergency" (Mendes, Tavares and Freiria, 2011; Oliveira et al., 2020). Therefore, in this study, the challenge was to carry out a dialogue between the multiple areas of expertise and knowledge in multiple scales to deal with intersecting vulnerabilities in a climate extremes context. We assume that vulnerability is a complex concept, including social, economic, political, and cultural dimensions, as well as other components of vulnerability such as physical and technological dimensions.

We based Iwama et al. (2016)'s method (See Figure 3, below) for interdisciplinary analysis of vulnerability encompassing:

- i. Spatial indicators and contextual analysis to validate the data;
- ii. Multiscale analysis of the phenomenon;
- iii. Mixed use of territorial approaches;
- iv. Participatory research and technical studies to engage society.

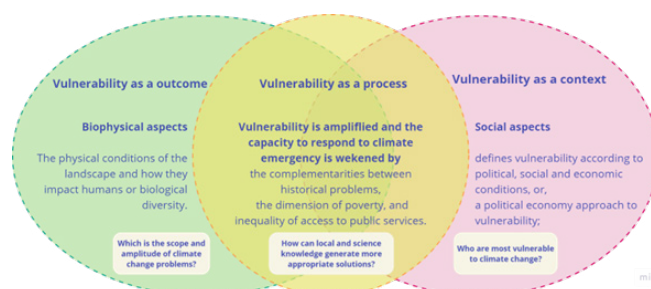


Figure 3. Scheme to analysis vulnerability as outcome, context, and process. Based on Iwama et al. (2016).

Since the most vulnerable are those living in areas that are more deprived, precarious, and more likely to be hit by extreme events, it is important to highlight the role of the territory. Acselrad (2013, p6) emphasises that the symbolic appropriation of territory has processes of a political nature, where the holders of collective memory gather to regenerate social practices in



areas of community use. Modes of material world appropriation articulate technical, social, and cultural practices, integrating the development models, which are in turn characterised by the prevalence of 'symbiotic agreements' between spatial practices, in which actors 'co-invent' themselves (Ascerald, 2004). However, a more integrative perspective of the territory is important to understand the uses of natural resources based on the society-nature relationship; and, to reveal how and where different actions are permeated by issues that are political, cultural, and ethnic (Carril, 2005). In this context, collective remembering becomes a strategy in our study to reconstitute part of what students' communities have lost or are threatened with losing (Acsehrad, 2013, 2013, 2004).

Given these approaches, Figure 3 provides the vulnerability framework in three axes (Iwama et al., 2016; Oliveira et al., 2020), taking the territory as a framework for our approach on Climate Justice Education (see the framework in Figure 4, below):

1. Biophysical aspects (vulnerability as an outcome): for example, the occurrence's probability of a hazard of geological or hydrological nature.
2. Social, political, and institutional aspects (vulnerability as a context): in the sense of the socio-spatial segregation mentioned above, with a bias towards those marginalised in high-risk areas.
3. Population's protagonism, which depends on a series of factors such as lived experiences, culture, pro-activism.

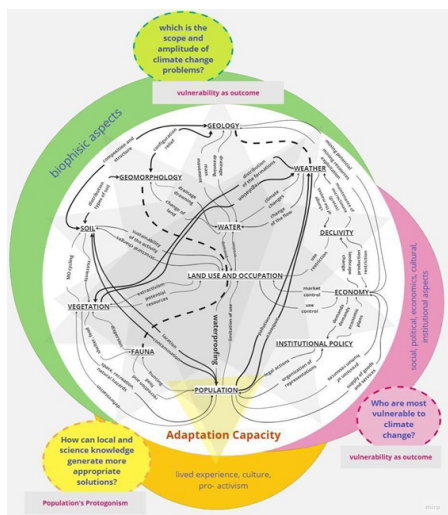


Figure 4. Vulnerability analysis conceptual model in three axes, taking the territory as a framework for Climate Justice Education. Adapted from Santos (2004, p. 127) and based on Iwama et al. (2016) and Oliveira et al. (2020) to vulnerability analyses.

Nussey (2021) discusses the need to use various strategies for learning about climate change. Artistic activities can be expressed in many ways in research to foster engagement between people and collaboration in the realisation of artistic activities. It can be used to raise awareness and alert the population to socio-

environmental issues (Gold-Watts et al., 2021), such as the impact of climate change. As an artistic expression, music has the power to trigger memories, feelings and reflections on personal life and moments of life in society that are marked in some way for those who remember (Jakubowski and Ghosh, 2021; Salakka et al., 2021).

In this research artistic strategies such as drawing, collage and music were used to represent extreme events to anticipate and educate for disaster prevention and to explain climate justice, using examples close to them and the territory they live in to understand how the process of human interference in climate issues takes place and the possible impacts. So, they could materialise the risks to which they are exposed and the possibilities of acting to prevent disasters in extreme climate events. These approaches are configured as other forms of representing climate impacts to facilitate understanding and the importance of the topic, bringing it closer to people's experiences and local contexts (Nussey, 2021). Remarks deepening the understanding of how different knowledge can be absorbed to promote coping with the climate crisis. Figure 5 (below) shows approaches to engage "with socio-cultural productions – linguistic, artistic, activist and participatory" (Nussey, 2021, p. 21) matched with the framework of vulnerabilities used in this study.

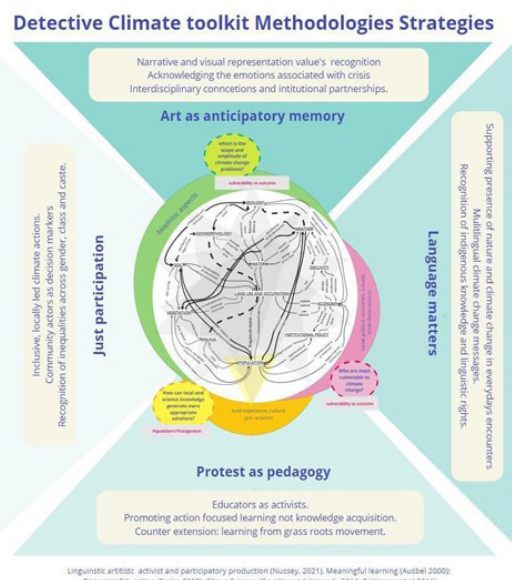


Figure 5. Climate Detective toolkit Methodologies Strategies for Education in Climate Justice. From Nussey et al., 2021 (p. 21)

The methodological guide for approaching the territory through Education for Climate Justice belongs to the perspective called "Extended Case Studies" by Burawoy (1991, 1998) which is in the field of participant observation in the social sciences and criticises positivist conceptions for the construction of knowledge. Furthermore, PAR methodologies have been approached on a dimension such as from those who advocate for alternatives in producing knowledge for critical climate justice⁷ (Sultana, 2021). It is based on co-creating scientific knowledge, prioritising and

7 "A critical climate justice perspective investigates how and why different groups of people face inequities in different ways from climate change, integrating insights from a range of academic theories (such as feminist, anti-racist, anti-capitalist, post-colonial, decolonial scholarship), as well as insights from activist movements for climate justice, in order to foster praxis of solidarity and collective action." (Sultana, 2021, p3).

valuing local specificities and knowledge to promote incremental and transformative socio-environmental impacts (Campos et al., 2016; Dickinson et al., 2012). We assume that PAR approaches are epistemological alternatives for constructing adaptive strategies for those who experience in diverse ways the effects of climate change in their daily lives. Our “Extended Case Study” resulted from a bottom-up process. It started from the bridge between teachers at MDV school in Eldorado Municipality (see Figure 6, below), Teacher LA⁸, and Teacher MC., and by the local activist AB., who was integrated into the research group.

Ribeira Valley has been an arena of dispute since its colonisation. The region is part of the first gold extraction cycle in Brazil. Thus, it presents the wounds of colonisation (Sultana, 2022) expressed in its socio-economic gap and territorial vulnerabilities resulting from historical environmental injustices (Herculano, 2008). In Latin America, environmental injustice is intricately linked to its colonial, extractivist, and slave-owning roots, in which nature’s destruction and human labour’s exploitation have been deeply reflected in social relations to this day (Pádua, 2002). Up to the 1980s¹¹, the conflicts due to land use were exacerbated by implementing new economic development and nature conservation projects. The implementation of parks expropriated several historical and traditional communities (Diegues, 2004; Carril, 2005), much of them deriving from slavery’s colonial past, which are called *quilombolas* (See Figure 7, below).

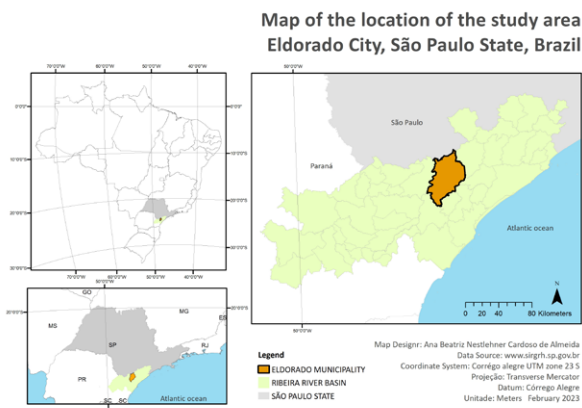


Figure 6. Map of the location of the study area of Eldorado Municipality, São Paulo state, Brazil. Designed by research group Ana Beatriz Nestleher Cardoso de Almeida data from (SIGRH-RB n.d.)

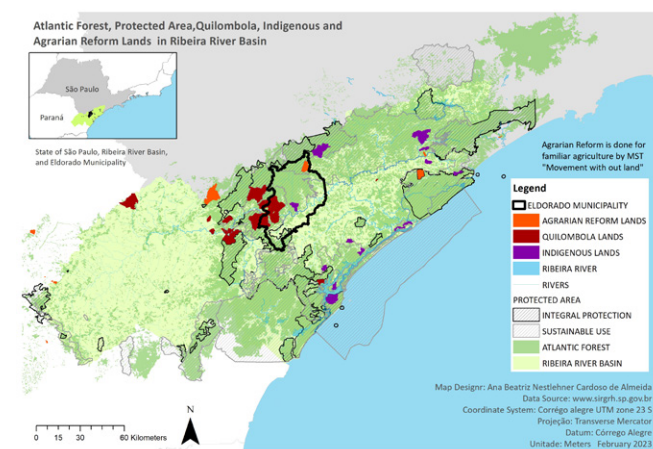


Figure 7. Map of Atlantic Forest Protected Areas in Ribeira Valley and legal land for quilombolas, Indigenous and MST¹². Taken from Research group, designed by Ana Beatriz Nestleher Cardoso de Almeida data from (SIGRH-RB, n.d.)

The teachers were looking for support to enhance student engagement, mainly because the school was implementing the new full-time education programme in 2022. The following part of the working paper presents some pertinent characteristics of the territory studied.

3. Contextual and Territorial Vulnerabilities Overview

Eldorado is a municipality of São Paulo State, located in the Ribeira Valley’s Region, which is a hot spot of ecosystem services⁹. Atlantic Forest¹⁰ corresponds to 75% of the Ribeira Valley basin (FEHIDRO, 2018). The environmental importance of natural resources was also internationally recognized by the United Nations, which declared it a World Natural Heritage Site in 1999 - The Southeast Atlantic Forest Reserves (UNESCO, 1999). Ribeira Valley is the region with the largest continuous of Atlantic Forest’s Protected Areas in Brazil.

In Eldorado, agriculture is the principal economic activity, followed by services and public employees. Eldorado still has a higher rural population than urban, which reinforces the role of agriculture in the local economy (IBGE, 2021). SEADE (2023) notes that in Eldorado’s rural areas, aspects of vulnerability and inequalities are exacerbated due to low wages, inferior quality infrastructure and insufficient public services. Eldorado presents one of the lowest socioeconomic development indexes of the State of São Paulo (IBGE, 2021; FEHIDRO, 2018; SEADE, 2021), with enormous social and economic vulnerabilities. The IPVS¹³ shows that Eldorado has 57.2% of the population in high social vulnerability, of which 49% live in rural areas (SEADE 2023).

8 The names of the teachers and students were replaced with random letters to maintain the anonymity of those who participated in the study.

9 Ecosystem services: the benefits people obtain from ecosystems. They can be divided into supporting, regulating, provisioning and culture (IPBES, 2019).

10 From 13 000 km² of remaining Atlantic Forest, around 8 500 are in Ribeira Valley (Carril, 2005)..

11 Until 1980 there was no land tenure in Vale do Ribeira, whose territory totalled about 1.5 million hectares. It is estimated that 700,000 hectares are still under public domain, in which it has been implemented as various protected areas (Carril, 2005).

12 The Movement of Landless Rural Workers (in Portuguese - MST) was constituted to fight for equitable distribution of land for agriculture by Agrarian Reform, available at <https://mst.org.br/>

13 The São Paulo Social Vulnerability Index (IPVS) aims to identify priority areas for combating social inequality (SEADE 2023).



Of the 5,572 Brazilian municipalities, Eldorado is one of 959 which are monitored¹⁴ by the National Centre for Monitoring and Alerts on Natural Disasters (CEMADEN, 2021). The Environmental Quality Report of São Paulo Municipalities (São Paulo State, 2021) identifies Eldorado as the municipality with the third highest number of residents directly affected by natural disasters in the state of São Paulo, with 70% of its households exposed to flooding (SIGRH-RB, n.d.) (SNIS-AP, 2022). Recently, severe Ribeira river floods in 1996 and 2011 caused great social, institutional, and economic damage to Eldorado (SGB, 2022). Transportation systems (roads, ferries, and small boats) are disrupted in any rainy season, deeply impacting the daily lives of the rural population (See Figure 8, below).



Figure 8. Small boats and ferries are used as means of transportation in Eldorado, São Paulo, Brazil. Research Group photo collection, 2022.

At the institutional level, the city is covered by the 'Environmental Agreement State of São Paulo 2030' to reduce carbon emissions (CETESB, n.d.). But there is no consistent evidence of effort to reach this climate commitment, although the Eldorado Municipal Plan of Civil Defence (Eldorado, 2012) is outdated. In Brazil, the Municipal Civil Protection and Defence Coordination is the body responsible for planning and coordinating civil defence actions in the municipality. Its main task is to understand and identify disaster risks in the region by mapping risks and preparing to deal with adversities.

In relation to education, Eldorado has one of the highest illiteracy rates (SEADE, 2021). All of Eldorado's 32 schools are public (eight run by state governments and 24 by municipal governments¹⁵) (INEP, 2022). It is important to note that the municipality has large rural areas and small urban centres. Six of eight state-run schools are in rural areas (INEP, 2022), while 19 of the total of 25 municipal schools are in rural areas.

MDV School

MDV is a state-run school, located in Itapeúna district, 12 km from the centre of Eldorado municipality. The school receives around 150 students from 10 to 17 years old (2021) from eight rural neighbourhoods, surrounding farms, and quilombo communities (São Paulo State, 2021). In 2021, the school had 16 teachers, and

11 non-teaching staff members, most residents from Itapeúna District, but also Eldorado Municipality, rural neighbourhoods, and other municipalities such as Cajati and Iporanga (Figure 9).

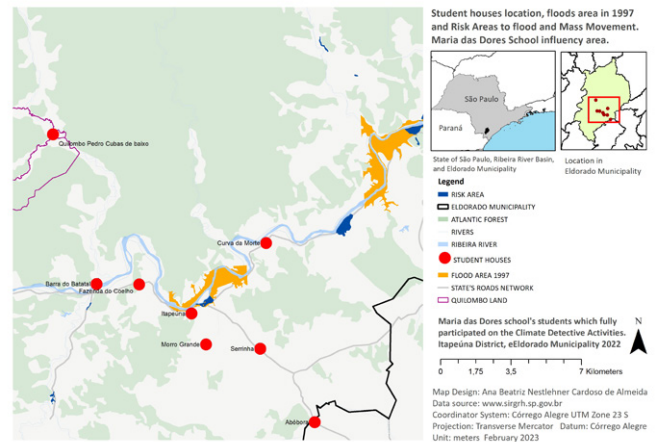


Figure 9. Risk of flooding and mass movement in Eldorado Municipality. Source: Ana Beatriz Nestleher Cardoso de Almeida data from (SIGRH-RB, n.d.).

Itapeúna District has been historically severely impacted by Ribeira River floods, since records started in 1803 (Eldorado, n.d.; IBGE 2021). The impact of extreme events also affects all of the school's catchment areas (Figure 9). The MDV School internal report (São Paulo, 2021)¹⁶ highlighted some of the important obstacles to overcome. Regarding teaching and learning activities, subjects related to languages (writing and reading), mathematics and logical activities are the most challenging ones. The difficulty of learning is related to several factors. The school accommodates students who attended primary education in rural schools, where classes are multigrade and lack technological infrastructure, which contributed to students with structural and disproportionate learning gaps. In this context, the school became a milestone in students' lives when they had the opportunity to have better conditions to study.

MDV School reported that students have several social and economic vulnerabilities (São Paulo, 2021). Families have, in general, low income, mostly from agriculture and handicraft services. Individuals with lower economic status cannot bear the costs required for disaster-resilient housing and infrastructure (Leal Filho et al.; 2019, Tran et al., 2008). Some students' family householders are itinerant workers in the agriculture sector and do not have a fixed residence, which not only harms students' schooling capacity, but exacerbates their family contextual vulnerability to climate change. Still, student absences and school dropouts are common among those who work in the agriculture sector to complement family income.

The social vulnerability and deficiency in living conditions are also evident among MDV school's students. Almost 40% of student's

¹⁴ CEMADEN monitors municipalities which have historical records and are at risk of disasters from mass movements or from hydrological processes.

¹⁵ In Brazil, municipal schools are run by the municipality. Each town is responsible for providing education from nursery school (crèches and pre-schools) to upper primary school (from 0 -14 years old). State schools receive funding and investment from the Brazilian state.

¹⁶ São Paulo, MDV School, Internal Report delivered to the research group. September 2021.

families receive *Bolsa Familia*¹⁷ which gives subsidies to families in poverty (São Paulo, 2021). Many students do not have access to an internet connection or reliable access to water, sanitation and hygiene (WASH) structures. The school accommodates students from several rural communities with evident territorial and social disparities.

4. Climate Detective Toolkit Development and Implementation

The Climate Detective toolkit research path was designed collectively with periodical meetings with Teacher MC (55 y, (m), Itapeúna, 2022), who became our key stakeholder and the representative of the project along with its implementation in the school. The Climate Detective toolkit shown here is based on dialogical education (Freire, 2000) in the understanding of how subjects perceive themselves in the world and how they perceive where they are, to incorporate the ecological-political-pedagogical principles of Freirean praxis. Furthermore, Halbwachs (1990) considers that the individuals' formation stands in the past-present connection of the "collective imaginary" of their various social frameworks, which are multiple, permeable and re-signified over time. The primary social framework is our family; however, it is constituted by the social groups with shared experiences in specific context. Collectively, each social framework establishes the memory of their past through its reconstruction based on the individual's current conditions (Middleton and Brown, 2005).

Considering the fluid relationship between past and present currents, narratives are transmitted through memory and the "collective imaginary" of the social frameworks (Halbwachs, 1990), across generation after generation of the family (Eguren, 2021). In this sense, the relationships of individuals with the past and future are strongly influenced by their present condition. Table 3 (below) shows our methodological educational framework route.

Time span	Climate perception	Guiding question	Technique used
Past	Climate Memories	What happened?	Interviews, Oral testimonies, hunt memories
Present	Climate Problems	What are you becoming aware of?	Circle of testimonies, transection walk, body-based awareness exercises
Future	Climate Solutions	How can you use what you learnt here?	Answer questions; design scenarios; draw solutions

Table 3. Guideline questions to temporal relationship about climate perception. Based on (Eguren 2021, p. 595).

We had three main engagement cycles with different methodological approaches and stakeholder's samples (see Table 4, right).

<p>Cycle 1 (Students from middle school and high school)</p> <p>All school students (150)</p>	<ol style="list-style-type: none"> Workshop in the school on the first day of classes (February 2022): "Participatory ground Mapping" Workshop in the school (April 2022) "Participatory neighbourhood Mapping"
<p>Cycle 2 (Students from high school)</p> <p>Up to 40 students.</p> <p>Deepening study with the elective classes "Innovation and Sustainability" led by Teacher MC. and Teacher JJ.</p>	<ol style="list-style-type: none"> Workshop in the school "Participatory collage" (May 2022) Average of 15 students: Development and implementation of the "Climate Detective" booklet (May and June).
<p>Cycle 3 (Students from high school)</p> <p>Five Climate ambassadors (Students: M., R.J., SA., EM., PC.) from the elective classes "Innovation and Sustainability" led by Teacher MC. and Teacher JJ.</p> <p>Climate Justice: Readings on the social and environmental impacts in Vale do Ribeira. A High School Scientific initiation with three students (AC., IO., SP) as CNPQ fellows supervised by Teacher RS. and research coordinator.</p> <p>* The National Council of Technological and Scientific Development (in Portuguese - CNPQ) funds research in Brazil.</p>	<ol style="list-style-type: none"> During July 2022, five Climate Ambassadors were responsible for assisting the project team in collecting data; supporting knowledge promotion in their school, as well as to bring proposals for action to tackle climate change in their city. From September 2022, three fellows have been oriented to research data about climate change in Ribeira Valley's Region in several language types (verbal, non-verbal or mixed), to analyse academic-scientific productions, to explore several languages in their homework, and to organise events in their school to disseminate their acquired knowledge. The project's main goal is to promote the deepening of scientific knowledge of high school students about climate change and its local socio-environmental impacts, contributing to disseminating information on the subject in the school community. The project has a one-year scope.

Table 4. Summary of the three cycles participation of activities into Climate Detective toolkit. Source: Research group, 2023.

In the first cycle, we organised ourselves to implement participatory exercises for all students, which enhanced collective discussion about weather characteristics, territorial disparities, and political action for climate justice. On this approach, the collage and drawings were registered by pictures and videos¹⁸. The data gathered supported the development of a diagnosis (Figure 10) about the occurrence of natural hazards and its implication in everyday life of students per neighbourhood.

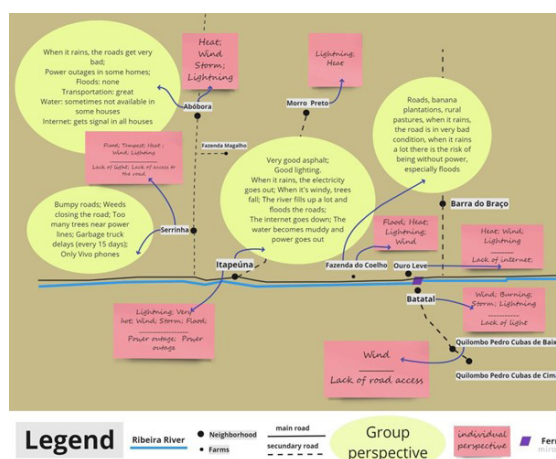




Figure 10. Conceptual map about the problems raised by students during Cycle 1 Climate Detective. Source: Research group data collection, 2023.

17 The *Bolsa Familia* is a Brazilian federal government programme of direct and indirect cash transfer to guaranteeing basic income for families. To be eligible for *Bolsa Familia*, the key rule is that each person in the family must have an income of, at most, US\$ 43.10 per month (Brazil, 2023).




18 These are available at: <https://www.youtube.com/watch?v=rQLMqMTxLNg>



This phase also reveals the role of housing locality, connectivity, mobility, and political conditions in the vulnerable aspects of the school community. A brief overview of the activities carried out in cycle 1 is shown in Table 5, below.

Cycle 1		
February 2022		<p>1. PARTICIPATORY GIANT GROUND MAPPING</p> <p>Project. Presentation for students. Students were asked to design their own houses and locate them, having the river, the school and city centre as reference. They were asked:</p> <ul style="list-style-type: none"> - To indicate the natural phenomena that most affect their houses. - To indicate the problems related to extreme natural phenomena. To walk around and observe the territorial disparities between neighbourhoods. - To talk about their neighbourhood situation and the difference that they could perceive during the activity.
April 2022		<p>2. PARTICIPATORY NEIGHBOURHOOD MAPPING</p> <ul style="list-style-type: none"> - Promotion of a circle discussion about the importance of diverse types of knowledge. - Organise children in small groups per neighbourhood. - Collective design of their neighbourhood and discussion about what happens with roads and communication networks, water supply systems, and rubbish during storms and winds.

From March 2022, due to school staff preference we had to narrow down our student sample for the ones enrolled in the "Innovation and Sustainability" elective high school class led by M.P. and J.S. teachers. Thus, in our second cycle, we reduced the sample from 150 students to an average of 15 students, which improved our condition to facilitate activities and register data, enhancing interaction capacity with students. It also provided a deep understanding about the qualitative data gathered from the participatory and individual activities. Moreover, despite the sample reduction, all students' neighbourhoods were still represented in the activities of Cycle 2. A brief overview of the activities carried out in cycle 2 is shown in Table 6, below.

Cycle 2		
May 2022		<p>1. PARTICIPATORY COLLAGE</p> <ul style="list-style-type: none"> - Discussion about climate change. - Recap of previous activities. - Reflection on "Brazilian seasons" by the composer, Alexandre Guerra. - Collective collaborative and participatory collage by MOVA methodology to express the four seasons in an artistic action.
		<p>2. FOCUS GROUP DISCUSSION OF CLIMATE MEMORIES</p> <ul style="list-style-type: none"> - Discussion around severe floods memories. - Collected testimonials from students' families, captured by audios and shared on digital platforms. - Explanation about climate change and its differentiated impacts, adaptation and mitigation concepts. - Identification of potentialities and challenges.
		<p>3. TRANSECT WALK IN THE DISTRICT OF ITAPEÚNA</p> <ul style="list-style-type: none"> - Explanation about children's rights in the global development and sustainability agendas and the influence of the built space to guarantee human rights. - Reading satellite imagery. - Identifying routes. - Critically territorial observation.
		<p>4. SITE IMMERSION AND INTERVIEWING TRADITIONAL QUILOMBO COMMUNITIES</p> <ul style="list-style-type: none"> - Territorial immersion. - Site and landscape observation; in the Quilombo Pedro Cubas, one student guided the research group presenting his family members, neighbourhood, agriculture field and housing environment.
June 2022		<p>5. COLLABORATIVE MAPPING USING SATELLITE IMAGERY:</p> <ul style="list-style-type: none"> - Spatial location. - Identifying their residences. - Locating problems and discussing the perception of land cover and territorial differences.

Tables 5 and 6. (left) (Overview of the Activities in Cycle 1 and 2 into Climate Detective toolkit. Source: Data from this study.

We visited five neighbourhoods during the field trip (territory immersion). In Itapeúna district and Quilombo Pedro Cubas we had students as guides, while in Abobral and Batatal there were on site observations and dialogue with local people. This field observation followed the guidelines in Table 7, below.

Observation guidelines		Question guidelines	
1.	Road network conditions	1.	How is the water, energy, and telephone supply?
2.	Traffic Signs	2.	Did the place change?
3.	Street lighting	3.	Which are the memories about the floods, in different rivers?
4.	Agriculture pattern: crops and livelihood	4.	How is land tenure?
5.	Forest fire	5.	How is forest management, for those living closer to natural parks?
6.	Housing characteristics	6.	What could be improved?
7.	Sanitation and waste.	7.	How is food production now, and how it was in the past?
8.	Water and energy supply (in houses)		
9.	Presence of children		
10.	Pollution (rubble)		

Table 7. Guidelines for field observation. Research group data collection, 2022.

Visiting the neighbourhood was fundamental to getting closer to students' reality and rapid appraisal of its key features of the territory. Also, during the territorial immersion (field trip) in May (2022), the research group realised that it was lacking a concrete methodological guide that could support teachers and students to better understand and follow activities about climate justice along the project's implementation. Therefore, the research group came up with an idea to design a booklet for students, which we called "Climate Detective" (See Figure 11, below).



Figure 11. The 'Climate Detective Booklet' is a tool that has the territory as a framework that seeks to raise people's awareness about how vulnerabilities are intensified by extreme weather events, as well as filling the information gaps using data collected by the students themselves and empowering them through citizen science. Source: NOSS USP- research group, 2022.

We developed this teaching-toolkit based on participatory territorial planning, such as transect walk¹⁹, scenario design, observation, and problem mapping (See Figure 12, below). In this way, the booklet consisted of open and closed questions for creative and critical reflective activities, alternating exercises by different languages, such as drawing and writing.

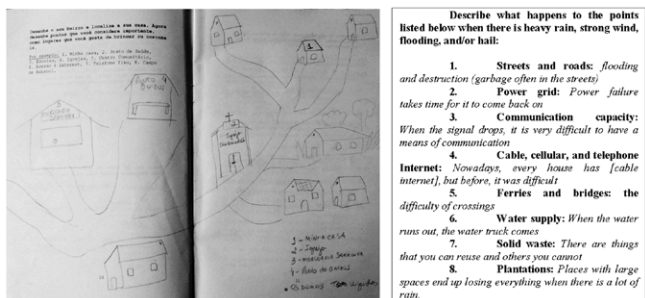


Figure 12. On the left, sketches of students' neighbourhoods, on the right translation of open questions regarding consequences of extreme weather. Source: Research group data collection, 2022.

The goal is to comprehend how students perceive themselves in the world and in their locality, as well as to promote the register of students' reflection on the subjects approached. The students' house, their neighbourhood, and community were set as exercise milestones, so the Climate Detective promotes data collection through students' personal experience to enhance their capacity of problem-solving, figuring out of scenarios, and the exercise of citizenship. In short, Table 8 shows the aim of each step of the 'Climate Detective' booklet.

Promote students' critical thinking concerning their reality, the perception of the effects of climate change and its consequences in their territory.	Debate on aspects of climate injustice based on recognising territorial differences between spatial scales: individual, housing, neighbourhoods	Identify problems and propose solutions in their specific territory.	Scenario design	Exercise of Citizenship	Primary and secondary data collection and validation for climate Action
--	---	--	-----------------	-------------------------	---

Table 8. Aim of each step of the 'Climate Detective' booklet. Research group data collection, 2022.

The Climate Detective booklet not only offers guidelines for learning climate justice but also provides qualitative and geographic data collection from students' perspectives and subjective experiences (See Figure 13, below), moreover by students themselves.

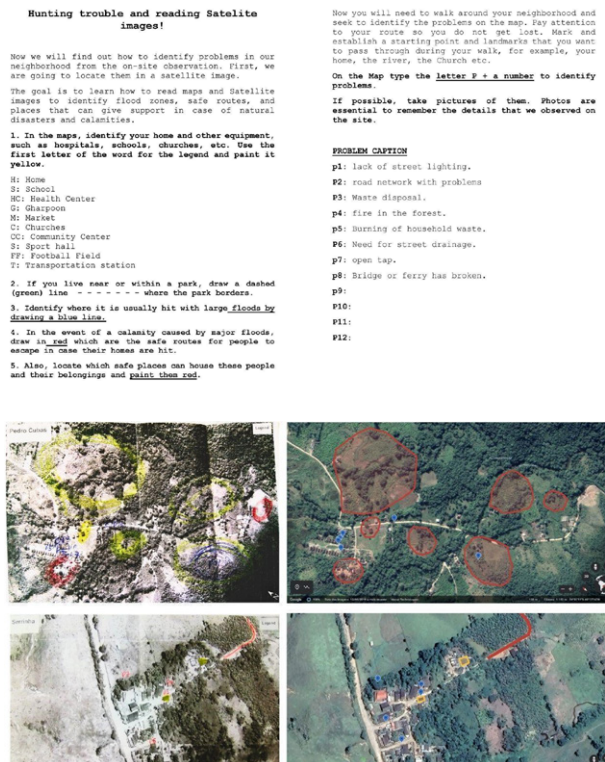


Figure 13. The guidelines for locating spatial features in satellite imageries, students sketches and GIS mapping. Source: Research group data collection, 2022.

In this context, students became the protagonists of knowledge production about climate injustice in their territory based on their own experience and collective memory. The Climate Detective toolkit activities made the students explore and talk from their territory, place of life, coexistence, and social relations as shown in Figure 14, below.

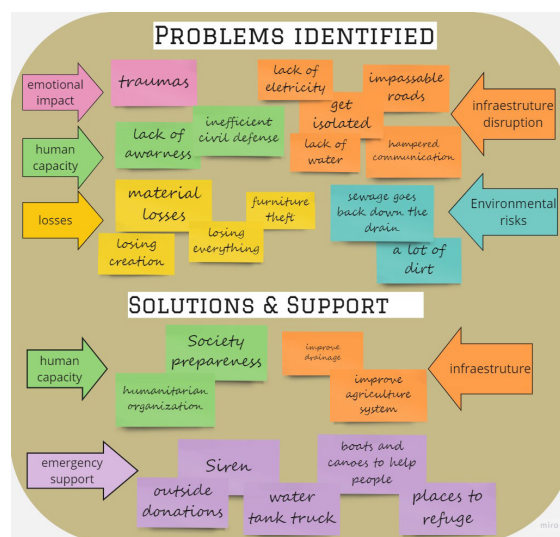


Figure 14. Main points of the focus group discussion on disaster memories in Eldorado. From this research, 2022.

19 It is a methodology called Rapid Appraisal, approached for general territory profile. See 'Land Degradation Assessment in Drylands- Methodologies and results', Food Agriculture Organization of the United Nations, 2002.

Thus, the Climate Detective toolkit is a pedagogical resource, which aims to enhance and integrate the student's learning experience and can promote a meaningful teaching-learning process. It seeks to expand students' analytical capacity on hazards due to climate change by having their territories as a framework (See Figure 15, below).

Most perceived natural phenomenon in students house								
Student's respondent (Name, age, gender, location)	Storm	Heatwave	Hail	Too cold/frost	lightning	Bushfire	Flood	River drought
M. 15 y (m) Fazendas Coelbo	1	1			1		1	
RJ. 17 y (m) Quilombo Pedro Cubas	1							
JG. 16 y (m) Serraíba		1			1			
JB. 15 y (f) Distrito Morro Preto		1					1	1
SS. 16y (f) (no information)								
PC. 17 y (f) Itapevins	1	1		1	1	1		

Problems related to the most perceived phenomenon in students house								
Student's respondent (Name, age, gender, location)	Lack of Light	Lack of water	Impassable roads	Internet outage	Landslide	Flooding of the house	Plantation loss	Loss of animals
M. 15 y (m) Fazendas Coelbo	1		1	1		1		
RJ. 17 y (m) Quilombo Pedro Cubas	1		1					
JG. 16 y (m) Serraíba	1			1			1	
JB. 15 y (f) Distrito Morro Preto	1		1	1				
SS. 16y (f) (no information)								
PC. 17 y (f) Itapevins	1			1			1	

Figure 15. Most perceived natural phenomenon and its consequences. Research group data collection, 2022.

The students' locality became the foundation for building knowledge of the world (Freire, 2000), thereby for understanding environmental and social impacts on various scales: their housing, neighbourhood, and municipality. From this perspective, MDV high school students' reality was included in the Climate Detective toolkit methodological path in more comprehensive totalities. Students could recognise the relationship of their reality, local and existential, with other dimensions: regional, national, and continental, planetary. Furthermore, they could be comprehend the reciprocal link between social, political, and economic perspectives that interpenetrate each other, as is demonstrated in Figure 16.

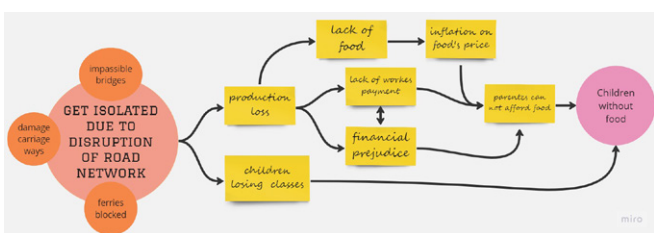


Figure 16. Multidimensional effects of road's network disruption over food security identified by the students during activities. Research group data collection, 2022

The methodological strategy articulated by the research team demanded teaching-learning methods that encouraged the acquisition and articulation of knowledge in an interdisciplinary and complex way, facilitated by the Climatic Detective toolkit. The structure of the exercises in the development of the Climate Detective booklet is shown in Table 9 (overleaf).

Cycle 3 (described in Table 10, below) resulted from the pilot project implementation. It started from small groups of high school students who personally engaged with the research proposal. In this cycle students took the lead in their tasks, developing their own strategies to collect data, acquire knowledge, and disseminate information.

Cycle 3		
June - July 2022		<p>Interviews application by students</p> <p>Each ambassador compromised to apply 10 surveys for young people up to 18 years old that live in Eldorado Municipality or nearby municipalities. The survey was an adaptation of an online consultation promoted by the United Nations Committee on the Rights of the Child in order to inform the General Comment on Children's Rights* and the Environment with a Special Focus on Climate Change (General Comment No. 26).</p> <p>The main objective of this data collection was to compare the international results, with the local perspective based on data collected by the students. Students were also invited to reflect on how they felt during the interviews, and about their findings.</p> <p>* The United Nations Committee on the Rights of the Child is taking a significant step to hold governments accountable for ensuring children live in a clean, green, healthy, and sustainable world.* https://childrightsenvironment.org/consultation/</p>
March 2022 - March 2023		<p>Multi-Language intervention during Water Day</p> <p>March 2023</p> <p>Music and poetry presentation.</p> <p>Board Games.</p> <p>Water-sensitive exposition.</p> <p>Presentations of Partial Research Results.</p> <p>Engagement with the local educational initiative "the water caretakers".</p> <p>Presentation at Eldorado Town Hall by student-researchers</p> <p>Student presentations about the importance of waterbody and riparian forests in the municipality.</p> <p>Engagement with local legislators.</p> <p>Engagement with the local initiative "The water caretakers" (Cuidadores da Água).</p> <p>Symbolic act of planting a tree to reforest the riparian forest along the Ribeira River, in the municipality of Eldorado, in places where flooding occurs due to lack of vegetation.</p> <p>*The course "Cuidadores das Águas do Ribeira" is held by FunBEA (Brazilian Fund for Environmental Education) and has financial support from the Committee of Ribeira de Iguape River Basin CBH-RB / FEHIDRO. Source: https://clariodoribeira.com.br/2023/04/25/os-cuidadores-das-aguas-do-ribeira-promovem-defesa-da-mata-cilar/</p>

Table 10: Overview of the Activities at Cycle 3 into Climate Detective toolkit. Source: Research Group and student's research group photo collection, 2023.

One of the citizen science contributions to public policymaking on climate change and disaster risk reduction is the promotion of Community-Based Monitoring: "a process in which interested citizens, government agencies, industry, academia, community groups and local institutions collaborate to monitor, track and respond to issues of common community [environmental] concern" (Conrad and Hilchey, 2011). In Brazil, the programme CEMADEN Education²⁰ invests in schools for community preparedness, spreading information and enhancing risk communication. In this context, the outcomes analyses of the Climate Detective toolkit demonstrated the potential of MDV School to become an epicentre of Community-Based Monitoring approaching citizen science to improve not only adequate and inclusive decision-making but also to enhancing community resilience through awareness, engagement and children and youth empowerment.

20 CEMADEN Education Programme available at <http://educacao.cemaden.gov.br/site/project/>

Collective activities		Climate Detective booklet	
Collective activity	Learning and reflection, data collection	Individual activity	Learning and reflection, data collection
		1) Can we learn more about you?	Socio-economic profile: (1) Age (2) Race (3) Family dimension (4) Connectivity conditions (5) Access to electricity (6) Mobility for school (7) Family economic activity (8) Leisure preferences (9) Study preferences
1) Collaborative mapping from the individual experience.	<ul style="list-style-type: none"> Spatial perception in relation to the school, natural landmarks and urban centre to colleagues in the same neighbourhood. Perception of natural phenomena and their most frequent impacts from your residence. Qualitative notes of difference on natural hazards frequency and its impacts among neighbourhoods. Reflection on differences. 	2) Understanding your environment	<ul style="list-style-type: none"> Identification of the most recurrent natural phenomenon and related problems. Affective and behavioural relationship with natural phenomena. Perception related to different types of flood activity Aerospace recognition and identification of spatial references for public use of the neighbourhood through design. Identification of problems in infrastructure related to natural phenomena.
2) Collaborative mapping as a community.	<ul style="list-style-type: none"> Work in an intergenerational group among colleagues in the same neighbourhood. Spatial perception as part of a community through collaborative design. Discussion in a focus group to identify the most frequent problems, but infrastructure related to natural phenomena. Self-management discussion groups. 		
3) Musical sensory reflection and collective collage representing seasons	<ul style="list-style-type: none"> Recognition of the history of the neighbourhood through the guided walk. Interview with family members and community leaders. Landscape observation. Use of records as a support for discussion about climate memories in the classroom, about the differences and main aspects raised in the statements. 	3) Hunting Memories	<p>Gathering testimony about the natural disasters that have most affected be generations for identification:</p> <ul style="list-style-type: none"> Material losses Understanding the experience of going through a calamity. Challenges and potentialities in times of crisis. Possible improvements in other times of crisis. Sensory reflection and artistic representation of the seasons.
4) Immersion in neighbourhoods and interview with local residents and community leaders.			
		4) Perceptions of aspects of pollution and environmental degradation	<ul style="list-style-type: none"> Identification of human activities that most impact the Ribeira Valley region and in the proximity of the residence. Solutions that could improve these conditions.
		5) Impact of nature conservation policies on local culture	<ul style="list-style-type: none"> Way of life. Feeding. Relationship between the community. Family dimension. Positive and negative aspects. Feeling of insecurity due to the parks.
5) Training for transect walk	<ul style="list-style-type: none"> Recognition of the territory as you walk. Training to look for observation of physical and environmental problems. Recognition of problems on satellite imagery. Discussion of the differences between neighbourhoods. 	6) Hunting, problems, designing solution on an aerial photo	<ul style="list-style-type: none"> Identify National Parks. Residence. Possible shelters. Identify risk and flood areas. Design escape route. Identify problems and develop solutions.
6) Collaborative mapping of giant satellite imagery			
7) Mapping of agents	<ul style="list-style-type: none"> Identification agents. Map relationships. Understanding different power relationships. 	7) Writing a letter for public officials to solve problems	<ul style="list-style-type: none"> Action for political claims. Provide a template for future claims.
8) Representation of roles	<ul style="list-style-type: none"> Play different roles for climate action. 	8) Designing scenarios	<ul style="list-style-type: none"> Project pessimistic and optimistic scenario. Identify the most vulnerable sectors. Projecting action in the face of calamity. Reflect on the different social positions and power of action.

Table 9. Collective and individual activities of the Climate Detective toolkit (subjects approached). Research Group data collection, 2022.



5. Climate Justice Education: Dialoguing with Teaching-Learning and Empowerment of Students and Teachers

The teaching-learning process needs to allow both the educator and the learner to understand themselves as part of the vulnerability, but also capable of enhancing their knowledge for responses to climate emergencies. Teacher AP's statement (below) highlights the importance of registration and monitoring by the population itself, and in this sense the citizen science proposal contributes to the empowerment of the population for discussions and decision-making.

"I participated in a project of S.O.S Mata Atlântica, [...] this was about 10-15 years ago We did... a physical and chemical analysis of the water at that time, we had a briefcase - we were oriented on how we should use those chemicals - there was a spreadsheet. The interesting thing was that we did a water analysis, there was a test where... we fed the bacteria in a temperature of 36°, at that time we didn't have a greenhouse to keep it, so the greenhouse was our body ... to keep the temperature and the next day... (At the time we still managed to count the numbers of bacteria) it became drinking water. I would like to have that access again to know "How is our water today?". (Teacher AP, 45y, male, white, Natural Science, Serrinha Neighbourhood, 2022).

To support students' understanding of their territorial vulnerability and spatial inequalities, the discussion of the procedural vulnerabilities present in the community of MDV school demonstrates the potential of the Climate Detective toolkit for a better understanding of the students of their reality and discussion of aspects of social inequalities in the territory. It is an example of how the active participation of the local population, which diagnoses the problems, understands how it is affected and appropriates scientific knowledge, as Iwama et al. (2016) argue:

"face and reduce the risks arising from problems that have been repeated historically - poverty, socio-spatial segregation, limited access of some social groups to basic urban infrastructure - or those that are to come, such as climate change".

The co-construction of activities with students and teachers was challenging for the research group because, in the Brazilian teaching model, decisions about how to teach and learn are imposed from the top down (according to guidelines from the Ministry of Education - MEC - and the State Government - State Department of Education) like a ready-made recipe. In this sense, it is interesting to note that this traditional model of teaching ends up distancing the content of the subjects taught from reality.

21 Brazilian Fund for Environmental Education (in Portuguese - 'Fundo Brasileiro de Educação Ambiental').

22 https://www.instagram.com/p/Cr1J4Xzu_LI/?igshid=YmMyMTA2M2Y=

On one hand, the project's activities co-construction in the MDV School was challenging. On the other hand, the local communities already have their local leaders, who develop several environmental education and citizenship projects in Eldorado. Children and youth engagement and protagonism play a significant role for climate action and education. It is worth highlighting the local leadership of teacher MC in the municipality, who promotes a joining of forces and an environment to promote resilience for populations of the Ribeira Valley region, seeking opportunities and protagonism for his students, such as the articulation with the municipality, FunBEA²¹ and students (participants of the research scholarship programme for high school), which was carried out in April 2023. The event at the town hall brought together teachers, families, students and councillors. It was broadcast live on the Eldorado's Town Hall channel on social media. Students presented the demand for preservation of the riparian forest to the town councillors (see Figure 17, below). The event ended with a citizenship action, the delivery of native tree seedlings to the councillors as a symbolic act to recover the riparian forest to reduce flooding. action research, and enhanced capabilities to research and disseminate climate change knowledge, as reported in this section, we could hope for more interventions to improve climate action in the country.



Figure 17. Students presentation about riparian forest and flooding in Eldorado's municipality. Teacher MC noted that the: "girls presented with mastery, full mastery, This shows 'that it is possible, through environmental education, to position civil society to guarantee their rights and defend their natural assets' [author translation]. Source: from Funbea Instagram²²..

This denotes the local leaders' mobilisation and the project held in MDV school culminated in this exercise of citizenship and opening a channel for dialogue between citizens with representatives of the city council. As we can see in the teacher RS's speech. "...It was the first time that students had a voice in the city council... they made an excellent presentation".

This case converges with the idea that citizen science becomes a conversation by demands, or movements, towards something much deeper: the questioning of how public-government relations should work, what roles citizens and non-specialists should be able to play in decision-making, and challenging long-standing norms that have excluded ordinary citizens from engaging in scientific and technical decision-making (Cavalier

and Kennedy, 2016). The gains are multilateral as the projects and scientists responsible get information and help its processing, the citizen scientists expand their knowledge, learn scientific methods, and gain more awareness of the importance of applying science in public policies. Further, society wins since the mobilisation for these public policies has effective results for the local population. This form of citizen participation has significant power to affect (and be affected by) the policy landscape. Thus, the notions of citizen science create tensions and compositions between science and politics: the field of established practices and spaces of production of scientific knowledge is widened; at the same time forms of political participation are questioned. These examples demonstrate how citizen science can provide opportunities for people from many backgrounds and cultures to use science to address community issues. In this context, we assume that disaster prevention, as well as actions during and after the occurrence of disasters can be related to the education and empowerment of citizens.

Then to enhance scientific knowledge co-creation about climate justice, the active participation of the students provided us with important data on the territory, filling information gaps on local features that are not available in official databases. It allowed the co-construction and improvement of the data collection instruments. One of the results of this research is the integration of prior, local, and ancestral knowledge with scientific knowledge in a dialogical manner; respecting languages and local cultures (Nussey, 2021). The proposal of the Climate Detective toolkit brings innovative strategies for teaching, learning, and building knowledge from the specificities of the territory.

Throughout the path of the research to empower students to act for climate justice, the activities and exercises sought to foster student protagonism, through the valuing of knowledge and the promotion of dialogical education and meaningful learning. The activities provide subsidies for practical situations in the processes of political communication and community discussion. In addition to the interest shown by the students in the classroom, many of them showed an interest in continuing the research outside school time.

Regarding promoting citizenship practices, cycle 3 is an example of such empowerment. The climate ambassadors took the lead in the research in collecting qualitative data and disseminating knowledge. Another example is the fellowship researchers, from high school, which have been increasingly engaging in extracurricular activities and occupying school spaces, engaging other students and local stakeholders, and occupying political decision-making spaces such as the Town Hall.

6. Lessons from the Case Study

A better understanding of vulnerability seems to be one of the biggest challenges of climate justice education, as it requires a multidimensional approach that encompasses different

perspectives and scientific and popular knowledge. It requires the participation of a range of actors, including citizens, politicians, managers, academics, and institutions that must work together to identify problematic situations, in a shared vision, although undoubtedly with distinct roles and responsibilities towards reducing vulnerability to disasters. This leads us to ask: How does the PAR methodology help us address the challenges of climate justice education in the context of the Global South?

Students' engagement extrapolated the teaching-learning process, achieving platforms in political arenas, not only sharing their knowledge, but also advocating for action faced by local climate injustices. Despite the small sample size, following up with students along the Climate Detective booklet implementation helped set up critical themes for data collection. Moreover, it was helpful to review how effective the Climate Detective toolkit was to reach and engage the audience and how we could improve our writing and participatory approach to enhance students' interactions. Furthermore, discussions on public understanding of science disregarded citizens' specialities. In this respect, citizen science was an opportunity to connect the youth and children with their local context as well as with science, to become more science-based citizens and to involve the community in dialogue and decision-making about climate risks, disasters and emergencies.

This educational strategy required the articulation and participation of various actors (researchers, teachers, students, families, and municipal authorities) in the process of co-creation of knowledge embedded in local reality and may also promote the exercise of citizenship for the students involved, as Marchezini et al. (2020) and Trajber et al. (2019) have argued. In Paulo Freire's perspective, all knowledge is built through an educational process, which motivates and drives transformative action (Freire, 1993, 1996, 2000). Therefore, our process challenged the student to enter deeper and broader levels of knowledge. In the meaningful learning perspective, the previous knowledge of everyone was valued for new knowledge reconstruction and re-signification (Ausubel, 2000). The immersion of the researchers and students in the continuous process of deconstruction and reconstruction of territorial identities present in Brazilian society (given by colonisation, slavery, migration, and loss of material living conditions) revealed the modes of territorialization, deterritorialization, and reterritorialization of the most vulnerable groups in the MDV school community.

The study presented the importance of disseminating climate justice in basic education, due to its environmental and cultural diversity in addition to its socioeconomic characteristics. We sought to show how this information together translates into climate injustices in the territory, which brings the need for a movement for climate justice. The Climate Detective booklet was the toolkit developed in this study to facilitate meaningful learning and to empower children and adolescent students in Itapeúna, Eldorado, São Paulo, Brazil to fight for climate justice. Furthermore, it is aligned with a citizen science perspective for prevention and monitoring of local climate events.



7. Final Remarks

How can dialogical and meaningful learning contribute to climate justice education? In this study, we related the potential of meaningful learning and citizen science as a pedagogical strategy to promote the protagonism of youth and children. The co-construction of the Climate Detective's toolkit took the territory as a framework. In this way, the methodological design process, implementation, and outcomes of the Climate Detective toolkit emphasised that the symbolic appropriation of territory is a process of a political nature, where the holders of collective memory gather to regenerate social practices of community use, as was stressed by Acselrad (2006, 2013a). This case shows us, the "reading of the territory", as Freire said (1993, 2000), is beyond the material, geological, biological and geophysical aspects.

Briefly, we would like to emphasise four main results of this case study.

1. Climate Detective's toolkit co-construction taking the territory as a framework.

Thinking about one's own territory contributed to students' engagement, which extrapolated the teaching-learning process, achieving platforms in political arenas, not only sharing their knowledge but also advocating for action faced by local climate injustices. Understanding concepts around climate themes was fundamental to reveal vulnerabilities and risks associated with the uneven occupation of territories. In this manner, the process of co-creation of the Climate Detective toolkit proved to be the first step towards the recognition of the territory itself, its potentialities and difficulties as shown by Acselrad (2006, 2013a, 2013b). Moreover, the educational strategy required the articulation and participation of various actors (researchers, teachers, students, families and municipal authorities) in co-creating knowledge embedded in local reality also promoted the exercise of citizenship for the students involved.

2. The teaching-learning methodological process enabled students and teachers to recognize that vulnerabilities are amplified by extreme climate events. It allowed them to foresee solutions and possibilities for climate action and adaptation.

The experience, in this case, has shown that the Climate Detective's methodology contributed to students and teachers recognizing that vulnerabilities are amplified by extreme climate events, enhancing the capacity to foresee solutions and possibilities for climate action and adaptation, as Marchezini et al. (2020) and Trajber et al. (2019) stress in their studies. This was only possible because meaningful learning (Ausubel, 2000) was a powerful strategy to deal with the challenge of critical thinking about climate issues with children and youth, since learning resources and teaching strategies allowed different concepts, which are often fragmented into different cognitive processes, to be integrated into a network of relationships. A better understanding of vulnerability

was one of the biggest challenges of climate justice education in this experience, as it required a multidimensional approach that encompasses different perspectives and scientific and popular knowledge (Sultana, 2021, 2022; Martinez-Allier et al., 2021). It required the participation of a range of actors, including citizens, politicians, managers, academics and institutions that needed to work together to identify problematic situations, in a shared vision, although undoubtedly with distinct roles and responsibilities towards reducing vulnerability to disasters (Campello-Torres et al 2020; Tran et al 2019; Leal Filho et al., 2019) in that school community.

3. The Climate Detective toolkit brings a series of techniques and instruments with intra and inter-scalar approaches that allow thematic, disciplinary, spatial and temporal analyses.

The application of the PAR methodology in this school community reinforced citizen participation as its cornerstone. The implementation of Climate Detective toolkit contributed to the collection of unprecedented data, as researchers and communities were able to better understand local dynamics and vulnerabilities. It allowed us to recognize the knowledges, potentiality and resilience of those who live in the territory on a daily basis. In this case, the data collected by the students filled in information gaps about the territory, enabling a deeper understanding of the intersection of multiple dimensions of vulnerability in their lives (Iwama et al., 2016). This was only possible due to a series of techniques and instruments with intra- and inter-scalar approaches used for thematic, interdisciplinary, spatial and temporal analyses, as recommended by several authors (List, 2006; Campos et al., 2016; Eguren, 2021; Nussey, 2021).

4. The Climate Detective toolkit implementation contributed to student empowerment through their knowledge expansion, learning scientific methods and gaining critical awareness of how science can improve local policies, mobilise communities and enhance students' protagonism. Climate Detective's toolkit co-construction taking the territory as a framework.

The Climate Detective toolkit brings practical activities that challenge the entire school community to reflect on the challenges of climate change in the local context. In this set of tools, the theme of climate justice (Sultana, 2022) was combined with the pedagogical potential of Freire's dialogic education, meaningful learning (Ausubel, 2000), as well as citizen science (Dickson et al., 2012; Cavalier and Kennedy, 2016). The Climate Detective toolkit's framework was based on the understanding that climate science, most of the time, disregards local specificities, in particular the reality of vulnerable communities. In this sense, having a 'toolkit approach' based on citizen science was an opportunity to connect young people and children with their territory, in order to involve the community in dialogue about climate risks, disasters and emergencies. Notably, Dickinson et al. (2012) pointed out that the term citizen science has blurred boundaries, since contributes to many forms of advocacy, such as educating public members about

findings and opportunities for participation, pushing for targeted regulatory changes based on scientific arguments, or confronting state or non-state actions that potentially cause socio-environmental damage. In this way, the citizen science approaches in the Climate Detective toolkit were revealing of how potent science is in improving our citizenship practices. In short, in the face of the climate emergency, it is challenging to know the process of “vulnerability” and to intervene in it, through an integrated, interdisciplinary pedagogical strategy shared with and by all, in a teaching-learning network. Here, collective memory became a strategy to reconstitute part of what communities have lost or are threatened to lose (List, 2006; Eguren, 2021). The approach to territory, territorialities and territorialization as an educational process has been gaining strength among movements fighting for rights, through the strengthening of memory, collective identity and the network of social relations, as highlighted by Porto-Gonçalves (2018). So the results of this study reinforce that an authentic education for climate justice should privilege citizenship practices.

Acknowledgements

The authors would like to acknowledge and appreciate the support from:

1. Climate-U team at University College London, and the funder, UK Research and Innovation (UKRI) for the opportunity.
2. The team at the Interdisciplinary Climate Investigation Centre, of University of São Paulo (INCLINE - USP).
3. The school community of MDV state school; with special thanks to the teachers MC and RS, and to the other teachers at the school, and to students and their families for sharing their knowledge and history with us.
4. During the implementation of the project activities, we talked to some teachers. We collected information about their profiles (Table 13), their work at the school and some testimonies about extreme events they have already experienced in Eldorado.



References

- Acselrad, H. (2013) O conhecimento do ambiente e o ambiente do conhecimento: anotações sobre a conjuntura do debate sobre vulnerabilidade. *EM PAUTA* 11, : 115-129.
- Ascerald, H. (2013) *Cartografia social, terra e território*. Rio de Janeiro: Universidade Federal do Rio de Janeiro.
- Ascerald, H. (2004) *Conflitos Ambientais no Brasil*. Vol. 11. Rio de Janeiro: Relume Dumará.
- Ausubel, D. P. (2000) *The acquisition and retention of knowledge: a cognitive view*. Dordrecht: Springer Netherlands.
- Brasil (2007). *National Decree 6040/2007*. Política Nacional dos Povos e Comunidades Tradicionais, Brasília: Casa Civil. Available at: http://www.planalto.gov.br/ccivil_03/ato2007-2010/2007/decreto/d6040.htm
- Burawoy, M. (1998). The Extended Case Method. *Sociological Theory*, 3: 4-33.
- Burawoy, M., Burton, A.; Ferguson, A. A. e. Fox, K.J. (1991) *Ethnography Unbound: Power and Resistance in the Modern Metropolis*. Berkeley: University of California Press.
- Campello-Torres, P. H. , Leonel, A. L. e Araújo, G. P. (2021). *Climate Injustice in Brazil: What We Are Failing Towards a Just Transition in a Climate Emergency Scenario?* Palgrave Macmillan, Cham,.
- Campello-Torres, P. H. , Leonel, A. L.; Araújo, G. P e Jacobi, P. R. (2020) Efecto Nueva Zembla y Justicia Climática en Brasil: adaptación sin justicia no es adaptación, es espejismo. *Terra. Nueva Etapa* XXXIV.
- Campello-Torres, P. H. (2021) Justiça climática e as estratégias de adaptação às mudanças climáticas no Brasil e em Portugal. *Estudos Avançados*. 35: 159-176.
- Campos, I. S., Alves, F. M.; Dinis, J.; Truninger, M.; Vizinho, A. e -Lopes, G.P. (2016). Climate adaptation, transitions, and socially innovative action-research approaches. *Ecology and Society*, v. 13.
- Carril, L. F. B. (DEc, 2005). Quilombo, território e geografia. *Agrária*, no. 3, p. 156-171.
- Cavalier, D., Kennedy, E. B. (2016) *The Rightful Place of Science: Citizen Science*. Tempe: Consortium for Science, Policy & Outcomes.
- CEMADEN (2021). *Municípios Monitorados*. São José dos Campos: CEMADEN. <http://www2.cemaden.gov.br/municipios-monitorados-2/> (acesso em 28 de April de 2023).
- CETESB. (n.d.) *Acordo Ambiental do Estado de São Paulo*. <https://cetesb.sp.gov.br/acordo-ambiental-sao-paulo/> (accessed 15 May 2023).
- Cutter, S. L. (2011) A ciência da vulnerabilidade: modelos, métodos e indicadores. *Revista crítica de ciencias sociais*, p. 59-69.
- Dickinson, J. L, et al. (2012) The current state of citizen science as a tool for ecological research and public engagement. *Frontiers in Ecology and the Environment*, 291-297.
- Diegues, A. C. (2004). 'Saberes Tradicionais e Etnoconservação'. in *Comunidades Tradicionais e Manejo dos Recursos Naturais da Mata Atlântica*. São Paulo: Hucitec: NUPAUB-USP: CEC.
- Eguren, I R. (2021) 'Memorialab: Dialogue, Memory and Social Healing in the Basque Country: A Methodological Note.' In: *The SAGE Handbook of Participatory Research and Inquiry*. D Burns, S Ospina and J Howard, (eds.) London: Sage. pp 592-607.
- Eldorado. (2012) *Plano Municipal da Defesa Civil*. Eldorado: São Paulo.
- FAO UN (2021) The impact of disasters and crises on agriculture and food security. Rome, 2021. <https://doi.org/10.4060/cb3673en>
- FEHIDRO. (2018) *Relatório do Comitê do Fundo Estadual de Recursos Hídricos da Bacia do Rio Ribeira de Iguape*. São Paulo: Relatório institucional, 2018.
- Frediani, A., and Nussey, C. (2021) A protocol for Participatory Action Research into Universities' Role in Climate Justice: Principles and tools. *Transforming Universities for a Changing Climate Working Paper Series*, No. 3. London: Climate U,.
- Freire, P. (1993) 'Ensinar, aprender: leitura do mundo, leitura da palavra.' In *Professora sim, tia não. Cartas a quem ousa ensinar*, in (ed.) Ribeiro, J. pp27-38. São Paulo: Olho D'Água
- (1996). *Pedagogia da Autonomia: saberes necessários à prática educativa*. 25°. Rio de Janeiro: Paz & Terra.
- (2000). *Pedagogia da Indignação: Terceira Carta Pedagógica*. 1°. São Paulo: UNESP
- (2008). *Pedagogia do Oprimido*. 45°. Rio de Janeiro: Paz & Terra.
- Gold-Watts, A., Hovdenak, M.; Ganesan, A. and Bastien, B. (2021). 'From Arts to Action: Project SHINE as a Case Study of Engaging Youth in Efforts to Develop Sustainable Water, Sanitation, and Hygiene Strategies in Rural Tanzania and India.' In: *Arts and Health Promotion* Corbin, J, Sanmartino, M, Hennessy, E. and Bjørnøy Urke, H (eds.) pp.141-163. Springer.
- Gonçalves-Dias, S. L. F., Cseh, A (2021). *Diálogos Políticos Universitários - Cúpula do Clima: do Internacional ao Municipal*. Oficina Municipal, São Paulo: CARI-UNESP.
- Governo do Estado de São Paulo (2021). *"Relatório de Qualidade Ambiental do estado de São Paulo."* São Paulo.
- Halbwachs, M. (1990) 'Memória Coletiva e Memória Individual.' In: *A Memória Coletiva*, by Halbwachs, M. (ed.) pp25-47. São Paulo: Vértice.
- Herculano, S. (2008) O clamor por justiça ambiental e contra o racismo ambiental. *Revista em gestão integrada em Saúde do Trabalho e Meio Ambiente* 3: 1-20.
- IBGE. (2021) *Cidades*. Brasília.
- INEP (2022). *Censo Escolar da Educação Básica*. Brasília: INEPDATA, MEC. Available at <https://inepdata.inep.gov.br/analytics/saw.dll?Dashboard>
- IPBES (2019). *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Edited by Brondizio, E., Diaz, S., Settele, J. and Ngo, T. Bonn: 1148.
- IPCC a (2022). *Annex II: Glossary*. *Em Climate Change 2022: Impacts, Adaptation and Vulnerability*, Möller, V. et al. (eds.) pp2897-2930. Cambridge, UK and New York, USA: Cambridge University Press.
- Iwama, A. Y., Batistella, M. Ferreira, L. C.; Alves, D. S. and L.Ferreira, L. C. (2016). Risk, vulnerability an adaptation to climate change: an interdisciplinary approach. *Ambiente & Sociedade* 19: 93-116.
- Jakubowski, K., and Ghosh, A. (2021). Music-evoked autobiographical memories in everyday life. *Psychology of Music* 49: 649-666.
- Kasperson RE, Renn O, Slovic P, Brown HS, Emel J, Goble R, Kasperson JX, Ratick S. (1988) The social amplification of risk: a conceptual framework. *Risk Analysis*, 8:177-187.
- Leal Filho, W, et al. (2019) Assessing the impacts of climate change in cities and their adaptive capacity: Towards transformative approaches to climate change adaptation and poverty reduction in urban areas in a set of developing countries. *Science of the Total Environment*. Vol. 692: 1175-1190.
- List, D (2006). Action research cycles for multiple futures perspectives. *Futures*, August : 673-684.

- Marchezini, V., Mendonça, M. B.; Sato, A. M., Rosa, T. C. S. and Abelheira, M. (2020). Educação para Redução de Riscos e Desastres: Experiências Formais e Não Formais no Estado do Rio de Janeiro. In: *Anuário do Instituto de Geociências*, Vol112: 102-117.
- Martinez-Alier, J, Owen, A.; Roy, B; Del Bene, D. and Rivin, D. (2018). Blockadia: movimentos populares contra os combustíveis fósseis e pela justiça climática. In: *Anuario Internacional CIDOB*: 41-49.
- Mendes, J. M., Tavares, A.O.; Cunha, L. and Freiria, S. (2011). A vulnerabilidade social aos perigos naturais e tecnológicos em Portugal. *Revista Crítica de Ciências Sociais*, 93: 95-128. Available at: <https://journals.openedition.org/rccs/90>
- Middleton, D., and Brown, S. (2005) 'Territorising experience: Maurice Halbwachs on memory'. In: *The Social Psychology of Experience: Studies on Remembering and Forgetting*, Middleton, D. and Brown, S. (eds.) London: Sage.
- Moreira, M. A. (2012). O que é afinal aprendizagem significativa? *Revista Quiculum*: 29-56.
- Nussey, C.(2021) Rethinking the unthinkable: what can educational engagements with culture offer the climate crisis? *Cultural Relations Collection*. London: British Council. Available at: https://www.britishcouncil.org/sites/default/files/cultural_relations_collection_2021_rethinking_the_unthinkable_charlotte_nussey1708.pdf
- Oliveira, E.L. (2018). Vulnerabilidade: a questão central da equação de risco. *Ensino & Pesquisa*, 22: 1-9.
- Oliveira, S. S., Portella, S. L. D.; Antunes, M. N. and Zezere, J. L. (2020). 'Dimensões da vulnerabilidade de populações expostas a inundações: apontamentos da literatura'. In: *Redução do Risco de Desastres e a Resiliência no Meio Rural e Urbano*, by Júnior, L.M. et al. (eds.) São Paulo: Centro Paula Souza.
- Pádua, J A. (2002) *Um sopro de destruição: pensamento político e crítica ambiental no Brasil escravista*. Rio de Janeiro: Editora Zahar
- Renn, O. (2011). The Social Amplification/Attenuation of Risk Framework: Application to Climate Change. *WIREs Climate Change*, 2: 154-169. <https://doi.org/10.1002/wcc.99154-169>.
- Roggero, M. A., Ziglio, L., and Miranda, M. (July 2018). Vulnerabilidade socioambiental, análise de situação de saúde e indicadores: implicações na qualidade de vida no município de São Paulo. *Confins*. Num.36. <https://doi.org/10.4000/confins.13774>
- SGB/CPRM (2022). *Serviço Geológico do Brasil*. Brasília: Geoportal.. Available at <https://geoportal.cprm.gov.br/desastres/?extent=-5373913.2017%2C-2829142.3599%2C-5361243.7642%2C-2822931.8513%2C102100> (Accessed January 18 2023).
- Salakka, I., et al. (may 2021) What makes music memorable? Relationships between acoustic musical features and music-evoked emotions and memories in older adults. *PlosOne*. May 14;16(5).
- São Paulo (2021). *Relatório interno sobre a situação da escola estadual MDV*. Internal project report: Climate-U .
- Sauer, S., and Wellington Almeida, W (2014). *Terras e Territórios na Amazônia: Demandas, Desafios e Perspectivas*. Brasília: EDU-UNB.
- Schipper, E. L., Ayers, J.; Reid, H.; Huq,S. and Rahman, A (2014). *Community-Based Adaptation to Climate Change: Scaling it up*. London: Routledge.
- SEADE (2023). *Índice Paulista de Vulnerabilidade Social*. São Paulo: SEADE . Available at: <https://ipvs.seade.gov.br/view/pdf/ipvs/mun3514809.pdf> (Accessed 15 May 2023).
- SEADE (2021). Fundação Sistema Estadual de Análise de Dados. *Perfil dos Municípios Paulistas*. São Paulo: SEADE. Available at <http://perfil.seade.gov.br/#> (Accessed 15 May 2023).
- Seballos, F., Tanner,T.; Tarazona, M. and Gallegos, N. (2011). *Children and Disasters: Understanding Impact and Enabling Agency*. Institute of Development Studies. Available at: <https://resourcecentre.savethechildren.net/document/children-and-disasters-understanding-impact-and-enabling-agency/>
- SIGRH-RB. (n.d.) 'Sistema De Informações Geográficas da Bacia do Ribeira de Iguape e Litoral Sul do SIGRH-RB Ugrhi 11' available at: <https://www.sigrb.com.br/?id=5#https://www.sigrb.com.br/?id=5#>. (Accessed May 15, 2023).
- Sultana, F. (2022). The unbearable heaviness of climate coloniality. *Political Geography*, v 99.
- Sultana, F. (2021). Critical climate justice. *The Geographical Journal*, 188, 118-124.
- Svampa, M. (2020). ¿Hacia dónde van los movimientos por la justicia climática? *Nueva Sociedad*, NUSO Nº 286: March-April. Available at: <https://nuso.org/articulo/hacia-donde-van-los-movimientos-por-la-justicia-climatica/> (Accessed June 11, 2023.)
- Toledo, RF de, LL Giatt i(2014). Challenges to participation in action research. *Health Promotion International*, 2: 162-173.
- Trajber, R., et al. (2019) Promoting climate change transformation with young people in Brazil: participatory action research through a looping approach. *Action Research*. v.17, n.1, p. 87-107.
- Trajber, R. (2017) 'Educação ambiental, mudanças climáticas e prevenção de desastres: por políticas públicas emergentes e emergenciais.'. In: *Diálogos de Saberes e Fazeres: Uma releitura dos 25 anos da trajetória da Educação Ambiental brasileira*. Silveira Guerra, M. (ed.) Pp81-91. São José: ICEP.
- Tran, P, R Shaw, G Chantry. (May 2008). GIS and local knowledge in disaster management: a case study of flood risk mapping in Vietnam. *Disasters*. 33(1):152-69
- UNDRR. (n.d.). 'UNDRR terminology'. Available at: <https://www.undrr.org/terminology/critical-infrastructure>. (Accessed on April, 12 2023).
- UNICEF (2021). *The Climate Crisis is a Child Rights Crisis*" New York: UNICEF. .
- UNICEF (2018). *Shaping urbanization for children, A handbook on child-responsive urban planning*. New York: UNICEF.
- UNICEF (2015). *Unless we act now: the impact of climate change on children*. New York: UNICEF. Available at: <https://www.unicef.org/reports/unless-we-act-now-impact-climate-change-children>
- UNESCO (2019). *Country Progress on Climate Change Education, Training and Public Awareness: An Analysis of Country Submissions under the United Nations Framework Convention on Climate Change*. Paris: UNESCO. Available at <https://unesdoc.unesco.org/ark:/48223/pf0000372164>
- UNESCO (1999). *Atlantic Forest South-East Reserves*. Paris: UNESCO. Available at: <https://whc.unesco.org/en/list/893/>
- WHO (2019). World Health Organization. *Healthy environments for healthier populations: Why do they matter, and what can we do?* Geneva: World Health Organization. Available at: <https://www.who.int/publications/i/item/WHO-CED-PHE-DO-19.01>



Appendix

To implement the Climate Detective, we promoted collective participatory activities, followed by individual homework on the booklet. The student frequency during the elective "Innovation and Sustainability" varied, with an average of 10 to 15 students, but just six (6) students delivered the booklet. The respondents' profile is shown in Table 12.

Student Id	High School Year	Address (neighbourhood location)	Age	Gender	Race	Householder activity
Student M. ¹	1st year	Fazenda do Coelho	15	Male	brown	Farm workers
Student RJ. ¹	3rd year	Quilombo Pedro Cubas	17	Male	black	General services
Student JG. ¹	2nd year	Serrinha	16	Male	brown	Market
Student JB. ¹	1st year	Sítio Morro Preto	15	Female	white	Farm workers
Student SS. ¹	No data	No data	16	Female	brown	No data
Student PC. ¹	3rd year	Itapeúna	17	female	brown	No data
Student SA. ²	2nd year	Itapeúna	16	Female	brown	No data
Student EM. ²	2nd year	Itapeúna	16	Female	brown	No data
Student AC. ³	2nd year	Serrinha	16	Female	black	No data
Student IO. ³	3 rd year	Itapeúna	17	Female	white	No data
Student SP. ³	3 rd year	Serrinha	17	Female	black	No data

Table 11: Students participating in the co-construction of the Climate Detective toolkit.

- 1: data from Climate Detective booklet
- 2: data from Climate Ambassador
- 3: data from Fellows' research (high school)

During the implementation of the project activities, we talked to some teachers. We collected information about their profiles, their work at the school and some testimonies about extreme events they have already experienced in Eldorado. Table 13 shows the profile of some teachers whose statements are cited in the results of this study.

Table 12: Sample of teachers' profiles.

Teacher ID	Age range	Subject	Gender	Race	Neighbourhood
AP.	41 to 50 years	Natural Science	Male	White	Serrinha
A.	no data	History and Geography	Male	no data	no data
JJ.	41 to 50 years	Sociology	Female	Brown	Eldorado Centre
J.	no data	Geography	Male	no data	no data
MC.	51 to 60 years	Natural Science	Male	White	Itapeúna
RS.	51 to 60 years	Portuguese and English	Female	Black	Itapeúna



Climate-U

Transforming Universities
for a Changing Climate

About Transforming Universities for a Changing Climate

Climate change is the most significant global challenge of our time, and many of its effects are felt most strongly in the poorest communities of the world. Higher education has a crucial role to play in responding to the climate crisis, not only in conducting research, but also through teaching, community engagement and public awareness. This study contributes to our understanding of how universities in low and middle-income countries can enhance their capacity for responding to climate change, through a focus on the cases of Brazil, Fiji, Kenya, India, Indonesia and Tanzania. In doing so, it contributes to the broader task of understanding the role of education in achieving the full set of Sustainable Development Goals.

Our partners

