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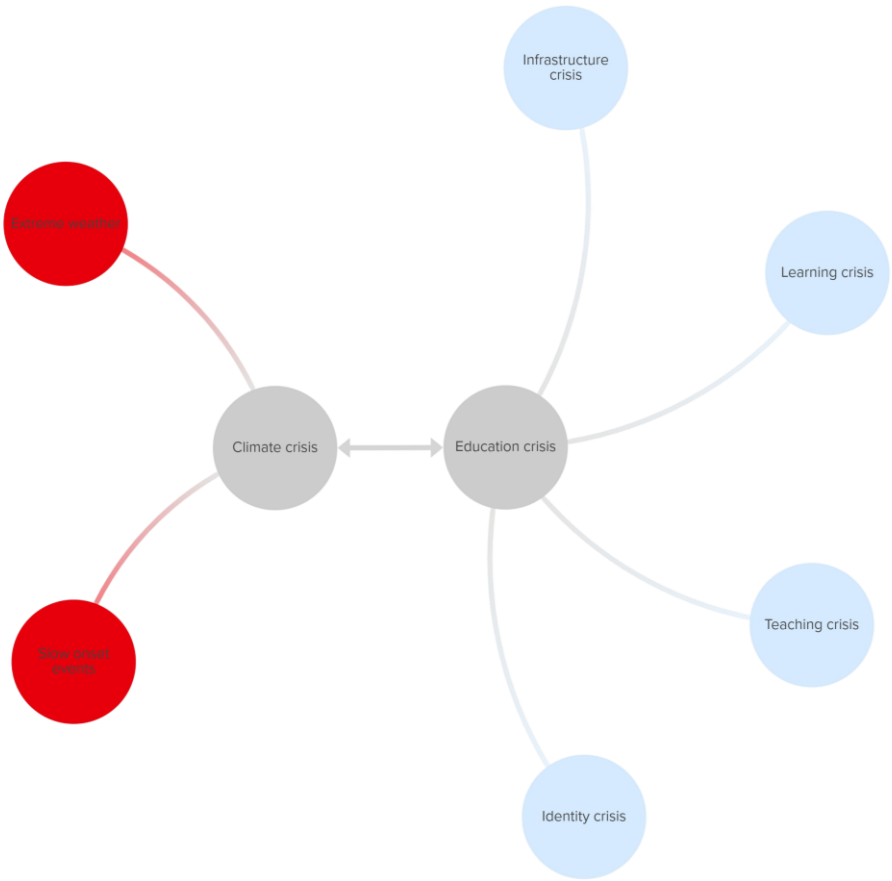
From crisis to leverage: mapping opportunities for climate-smart education systems.

A small-scale integrative research review



From crisis to leverage: mapping opportunities for climate-smart education systems.

A small-scale integrative research review

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Master's Thesis
Spring 2023
Master's in Education Entrepreneurship
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ABSTRACT

Oulu University of Applied Sciences
Master's in Education Entrepreneurship

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Title of the thesis: From Crisis to Leverage: Mapping Opportunities for Climate-Smart Education Systems
Thesis examiner: Sari Alatalo
Term and year of thesis completion: Spring 2023 Pages: 63 + 2 appendices

Our global education system suffers from an ongoing learning crisis, teaching crisis, infrastructure crisis, and identity crisis. Simultaneously, our planet's boundaries are being broken and the effects of it compound the already complex education crisis. Yet, it is not only doom and gloom. For those who know where to look, solutions can be found. Issues of the scale and complexity such as the education crisis and the climate crisis require an appropriate language and lens to discuss them properly. Where linear thinking fails to grasp the intricacy, convolutedness and interconnectedness, systems thinking does exactly that.

While much has been written about both of these crises separately, discussing them jointly and with an opportunistic perspective is still a novel notion. It is that what this thesis aims for. In addition to comprehensively mapping elements and connections in and between both these crises, this thesis also seeks to identify opportunities for leverage points that can help to transform the education system into a climate-smart system. A climate-smart education system uses internal and external challenges as opportunities to not only address its own pain points but also to contribute to solutions for the climate crisis.

To inform this mapping, a small-scale integrative review was conducted in which the PRISMA reporting guidelines directed a staged selection and review process. Eventually, twenty-three high-level publications by intergovernmental organisations and global research organisations were reviewed in-depth, which surfaced 116 data points. A rigorous qualitative content analysis then allowed the systems map to be constructed around the key concepts, constructs and ideas that emerged from the literature. In the map, thirty-six opportunities for leverage points offer the future users of the map data-driven options and guidance. The systems map was put to the test in an illustrative case, in which the education and climate context in Vietnam is used as a backdrop to identify how the map can be operationalised and prove its value.

The map resulted in being a comprehensive, versatile, and relevant instrument for governments and policymakers, actors in the international development sector, future researchers, and other potential users. It can be used as a starting point for discussions, a tool to get unstuck, or a guide for specific use cases. Ultimately, though, it is the facilitation of turning challenges into opportunities that gives this living systems map its most significant value.

With the identification of the thirty-six opportunities for leverage points, the map empowers the notion that we can solve the climate crisis and the education crisis together, which was the initial trigger to embark on this journey.

Keywords: systems thinking, climate crisis, education crisis, interconnectedness, systems map, leverage points, climate-smart education system

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LIST OF ABBREVIATIONS

BBC	British Broadcasting Corporation
GPE	Global Partnership for Education
IIEP	International Institute for Educational Planning
IPCC	Intergovernmental Panel on Climate Change
MOET	Ministry of Education and Training
NORRAG	Network for international policies and cooperation in education and training
NPR	National Public Radio
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RISE	Research on Improving Systems of Education
RQ	Research Question
SDG	Sustainable Development Goal
STEM	Science, Technology, Engineering, and Mathematics
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

1 INTRODUCTION

The global education crisis and the climate crisis are two of the most pressing issues of our time, which are both constantly evolving. The need for ongoing research is clear and ever-growing to provide accurate, timely and actionable insights to lead the global society in addressing these crises. With this master's thesis, the aim is to contribute to that ongoing research, using systems thinking as a lens to provide a holistic view on the interconnectedness between both crises.

It is often said that we cannot solve our problems with the same thinking we used to create them. While this popular quote is usually attributed to Albert Einstein, no original source or citation can be found to prove that. Regardless, it may still guide the rationale to choose for the holistic approach in this thesis. Both the climate crisis and the global education crisis have grown to the proportions they are at now, partly because we failed to understand, and later acknowledge, how interrelated the different components of our global ecosystems are (Global Education Futures, 2018; Shapiro, 2023). An example that illustrates this exactly is the discovery of more than 17 tonnes of plastic waste on Henderson Island, one of the world's most remote places (Lavers & Bond, 2017). How did we go from the invention of plastic in 1907 in New York to 37.7 million pieces of plastic waste on an uninhabited island more than 5000 km away from the nearest human habitation in 2017?

Issues of the size and complexity like the global education crisis and the climate crisis require a fundamentally more comprehensive way of thinking to find sustainable solutions. Systems thinking provides that needed holistic approach. A concise but fitting description of systems thinking by Ballew et al. (2019) delineates that it is "the tendency to perceive phenomena as interconnected and dynamic." This matches exactly with the premise of this thesis, which is to explore the interconnectedness between the two crises, both of which are constantly evolving.

An inspiring example of a successful application of systems thinking within the confines of the themes of this thesis can be found in the Montreal Protocol. This Montreal Protocol, which was signed in 1987, formalized the goal of preserving and repairing the ozone layer by drastically reducing the amount of ozone-depleting gases released into the atmosphere. All 198 UN member states have ratified it, making it the only UN treaty to do so (Torkington, 2023). US State Department, Chief US Negotiator on the Montreal Protocol Richard E Benedick (2005) testifies: "To fully understand the implications of a diminishing ozone layer, scientists […] had to examine our planet

as a system of interrelated physical, chemical, and biological processes on land, in water, and in the atmosphere – processes that are themselves influenced by economic, political, and social forces. The Montreal Protocol thus became a truly multi- and interdisciplinary effort.".

So far, this introduction has been focused mostly on the climate crisis. A second popular quote can serve as a segue into the education system. None less than Nelson Mandela taught us that "education is the most powerful weapon we can use to change the world" (2003). Whether that is an objective truth or not, it makes sense to look at the education sector and include it in the efforts to find holistic solutions for the climate crisis, as the challenges at hand often intertwine the two fields. Through education, we can capacitate present and future generations to prepare for the negative effects of climate change and take adequate measures to avoid or reduce the harm they can cause, or to seize any opportunity that might rise from it, which is what climate change adaptation entails (European Environment Agency, n.d.). Through education, we can also find solutions to lessen the severity of the effects of climate change by avoiding or lowering the atmospheric emissions of greenhouse gases, which is what climate change mitigation entails (European Environment Agency, n.d.).

Reversely, climate change has complex impacts on the education system. UNICEF categorizes these impacts as direct effects due to infrastructure damages and possible injury which can disrupt the learning process for a long time, and indirect effects that not only increase absenteeism, dropouts and threaten learning, but also negatively impact the wellbeing and security of children and adolescents (2019).

And then there is a whole other dimension to be considered as well. Air pollution exposure has now been linked to lower cognitive functions, developmental disorders like ADHD and autism, depression and anxiety, and has even been linked to neurological changes in children's brain development. Additionally, studies have demonstrated how climate-related displacement affects children's mental health, including post-traumatic stress disorder, anxiety, and depression (Perera, 2022). This is especially alarming since solving the challenges at hand, there is a growing need for new innovations and creativity, which are exactly the areas that are being impacted by these effects.

Hunter Gehlbach (2022), director of the Johns Hopkins School of Education Ph.D. program, suggests that we should start thinking about climate change as a modern education problem, in contrast to the currently used lenses of approaching it as a technological, economic and/or geopolitical

problem. Looking at climate change through an education lens, he claims, helps to highlight the complexity of the issue, involving emotional, attitudinal, motivational, and behavioural dimensions. He identifies four distinct benefits to this approach: increased optimism and energy, increased curiosity, constant prioritization, and stronger intergenerational alliances. Similarly, Beardmore and Pankhurst (2022) advocate in the Global Partnership for Education (GPE) blog that we can solve the climate and education crisis together. They state that the education sector is at the forefront of efforts to increase climate change resilience. Better planning and preparation within the sector could strengthen this role, while also reducing the impact of climate-related disruptions on education.

Undoubtedly, education is a crucial component of climate change mitigation and adaptation (UNICEF, 2019). On the other hand, the education sector itself is also experiencing a global crisis (World Bank, 2019). Although this is a very complex, multifaceted, and longstanding issue, the crisis can be summed up quite simply: a staggering number of children are not receiving the quality education they deserve. Either they are not receiving any schooling at all, or the quality of what they learn and how it is learnt is not adequate. This violation of the fundamental human right to education "limits economic development and locks countries into cycles of low growth rates, limited employment opportunities and weak social cohesion" (UNESCO, 2013).

All in all, both the education crisis and the climate crisis are issues of hefty complexity and colossal scale. We need to figure out how the education sector can play a role in addressing the climate crisis and fulfilling its premise of being the most powerful weapon we can use to change the world. There is also a need to consider if working towards increased climate readiness can be an opportunity to positively impact the global education crisis. These are the ideas that triggered the need to dig deeper into this intersection between education and the climate crisis.

Thanks to the scale and urgency of both the climate crisis and the global education crisis, high-quality and up-to-date literature on both issues is abundant and easily accessible. Research on the interconnectedness between these two issues is emerging and different models and frameworks are proposed (Fitzpatrick & West, 2022; Global Partnership for Education, 2023; Kwauk & Casey, 2022; Newman & Smith, 2021), each with their own angle. What seems to be still missing is a comprehensive, holistic consolidation that captures a neutral, generic perspective, brought together in an accessible and useful framework that accommodates the complexity, scale and evolving nature of both crises and their interconnectedness. The purpose of this framework could be to inform

governments and policymakers, facilitate thought processes for actors in the international development sector, and encourage future researchers to consider a holistic view in research work that is often deliberately narrow by nature, among others.

To address the lack of this global overview, this thesis aims to review the flagship reports of the most relevant intergovernmental organisations as well as a small scope of supporting journal articles, white papers, blog posts from reputable sources, and webpages. Using a systems thinking lens, this review is to inform the creation of a comprehensive yet living system map, meaning that it is not the intention to create a final and static map but rather one that captures the key components that are being discovered in the review and remains open for future additions and edits if and when additional research and insights emerge.

Ultimately, the aim is to apply, test and validate the newly developed systems map in an illustrative case. One specific element of the map will be examined in one specific geographic context, to validate whether or not the map helps to expose connections that may lead to insights and solutions that otherwise might be prone to be overlooked.

Keeping the purpose of this thesis in mind, the research questions (RQ) can be defined as follows:

> **RQ1:** What are the elements and connections in a generic systems map that maps the interconnectedness between the global education crisis and the climate crisis?
> **RQ2:** How can the newly developed systems map inform leverage points for its users?
> **RQ3:** How can the newly developed systems map be applied?

This introduction provided the reader with a background and rationale for this work and clearly articulates the research purpose and the research questions. In the next chapter, the key concepts of this thesis (global education crisis, climate crisis and systems thinking) will be further elaborated in a theoretical framework. The methodology chapter expands on the choice to conduct an integrative research review and how the process of the review unfolds. After presenting the results, the author discusses and interprets the findings and their implications, addresses the limitations of this work, and provides recommendations for further research.

2 THEORETICAL FRAMEWORK

2.1 The global education crisis

In the introduction, a reference was made to UNESCO's assessment of the global education crisis that frames the crisis poignantly as a staggering number of children who are not receiving the quality education they deserve. It is a human rights violation with dire consequences on both the micro (individual development) and the macro level (national and global development), limiting employment opportunities and economic development (2013). A further unpacking exposes an array of different ways in which this global education crisis manifests itself.

First and foremost, a learning crisis is the most evident manifestation of the global education crisis. Significant progress has been made in expanding access to education in recent decades, yet it is estimated that even before Covid-19, there were almost 260 million children around the world who were not in school (Global Business Coalition for Education, 2022). Furthermore, as World Bank puts it, "being in school isn't the same thing as learning and worldwide, hundreds of millions of children reach young adulthood without even the most basic skills in reading, writing and mathematics" (World Bank, 2019).

It is hard to overestimate the impact on society. The global economy needs educated workers, but by 2030, more than 800 million young people worldwide will not have the fundamental skills required for that workforce (Global Business Coalition for Education, 2022). According to World Bank data, 56 per cent of youth worldwide will be less than half as productive as they could be if they had access to proper education and good health (World Bank, 2019).

A second manifestation of the global education crisis is a teaching crisis. Teachers are generally acknowledged as the most important classroom factor influencing student learning (Hattie, 2015). Students need competent teachers in order to learn – yet many educational systems give little consideration to what teachers know, their classroom activities, and in some cases, even their attendance (World Bank, 2019). Additionally, the teaching profession generally suffers from decreased attractiveness resulting in a global teacher shortage crisis. UNESCO (2023) reports that, to reach universal basic education by 2030, 69 million teachers are needed. Sub-Saharan Africa

has the biggest deficit, but it is truly a global issue. According to the National Education Association, the USA is facing a shortage of 300.000 teachers (NPR, 2022), which is exacerbated by the fact that 48% of teachers in the USA have considered quitting within the last 30 days according to a recent survey (Perna, 2022). In Europe, Germany is estimated to lack 25.000 teachers by 2025, Portugal will experience a shortfall of 30.000 teachers by 2030 and in France there are currently 4.000 vacant teaching positions (Euronews, 2022), just to name a few examples. Some of the main factors that influence the attractiveness of the teaching profession (in the U.S.) are salaries and other compensation, preparation and costs to entry, hiring and personnel management, induction and support for new teachers, and working conditions (Podolsky et al., 2016).

A third manifestation is the infrastructure crisis that is unfolding, in addition to the learning and teaching crisis. To accommodate the 260 million children who are currently not in school and to relieve the overcrowded classrooms that are currently commonplace in many countries, millions of new classrooms are needed. Yet already now, education infrastructure shortages are a barrier to learning at all income levels, with particular impact on the most disadvantaged schools (UNESCO, 2017). Many schools lack basic infrastructure to support safe and healthy learning environments. UNICEF and WHO (2020) report that 818 million children lack access to basic hygiene facilities like clean drinking water or bathrooms at school. In the U.K., 700.000 students are already learning in buildings that need replacing, and schools lack 3 billion pounds per year in funding, which means that number will keep getting bigger. With 500 new schools being built over 10 years, it currently takes over 430 years to renew every school in England on that timeline (Cruddas, 2023). The United States spends 46 billion dollars less per year than is required to maintain safe and sanitary facilities in schools (Brown, 2021).

A fourth way in which the global education crisis manifests itself can be described as an identity crisis. Education reforms are necessary and ongoing to keep up with the increasing pace of change in today's society, but global education experts disagree on what should be prioritised. While one group advocates focusing on improving foundational learning (i.e. numeracy and literacy), the other side argues for a more holistic approach, which embodies social and emotional learning alongside academic competencies (Edwards, 2023). While this may be a false dichotomy (The LEGO Foundation et al., 2023), the debate very much exists. In a new book by the late Sir Ken Robinson and his daughter Kate Robinson, in which they advocate redesigning education for the future, they define four core purposes of education: personal, cultural, economic, and social, but acknowledge

that the purpose of education is an “essentially contested concept” that can have different meanings to different people (Robinson & Robinson, 2022).

While these four intersecting crises (learning crisis, teaching crisis, infrastructure crisis and identity crisis) are not an exhaustive summary to describe the global education crisis, they do touch upon the core components of an education system and can provide a relevant framework for further analysis in this thesis.

2.2 The climate crisis

Explaining what the climate crisis is about may almost seem redundant at this point as the conversation has been ongoing for decades and there is a general scientific consensus that the earth is warming due to human activity (Cook et al., 2016; Myers et al., 2021; Powell, 2017), which is a global security threat and even an existential threat (United Nations Security Council, 2021). Within the context of this thesis, it is mostly relevant to frame the concepts that portray the dynamics to address this crisis, which can be defined as climate change adaptation, climate change mitigation and climate resilience, to become climate-ready and climate-smart.

The concepts of climate change adaptation and mitigation have already been mentioned in the introduction, using definitions from the European Environment Agency. Where mitigation is about preventing or reducing the emission of greenhouse gases into the atmosphere, adaptation means changing our behaviour and systems to protect ourselves from the consequences of climate change (World Wildlife Fund, n.d.). Brown (2014) describes adaptation and mitigation as “conceptually complementary strategies for minimizing climate change impact”. He goes on to explain the importance of using both approaches in an integrated way to avoid policy conflicts.

Climate resilience is defined by the Intergovernmental Panel on Climate Change as “the capacity of social, economic and ecosystems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure as well as biodiversity in case of ecosystems while also maintaining the capacity for adaptation, learning and transformation (IPCC, 2022).” Grasham et al. (2021) add a political dimension to this definition, claiming it is “a political process that strengthens the ability of all to mitigate vulnerability to

risks from, and adapt to changing patterns in, climate hazards and variability". To be climate resilient can be understood as having the capacity to design and implement climate adaptation and mitigation strategies.

Through climate resilience, systems (e.g. nations, or agriculture or education systems) can become climate-ready and even climate-smart. While it proves to be challenging to find formal definitions for these concepts, climate readiness can be understood as an organisation's or system's status on embracing and addressing the consequences of climate change and environmental issues (UNICEF, 2020) and includes developing and implementing adaptation and mitigation strategies. Once an organisation or system becomes climate-ready, it can become climate-smart. What climate-smart means, depends on the context of the organisation or system. In agriculture, where the term seems to be mostly used, it refers to strategies to change and reorient agriculture systems to support food security in light of the new climate change realities (Lipper et al., 2014). For education systems, being climate-smart can refer to maximizing the benefits of efforts to promote environmental sustainability, foster climate resilience, and ensure high-quality education for all (Global Partnership for Education, 2023). In both cases, it adds an extra layer to being climate-ready, namely by going beyond reacting to climate change and using the challenges it presents as opportunities to both improve its own function or goals (e.g. food security or quality education) and be part of the solution to climate change.

The different concepts that portray the dynamics to address the climate crisis and how they relate to each other can be schematised in figure 1.

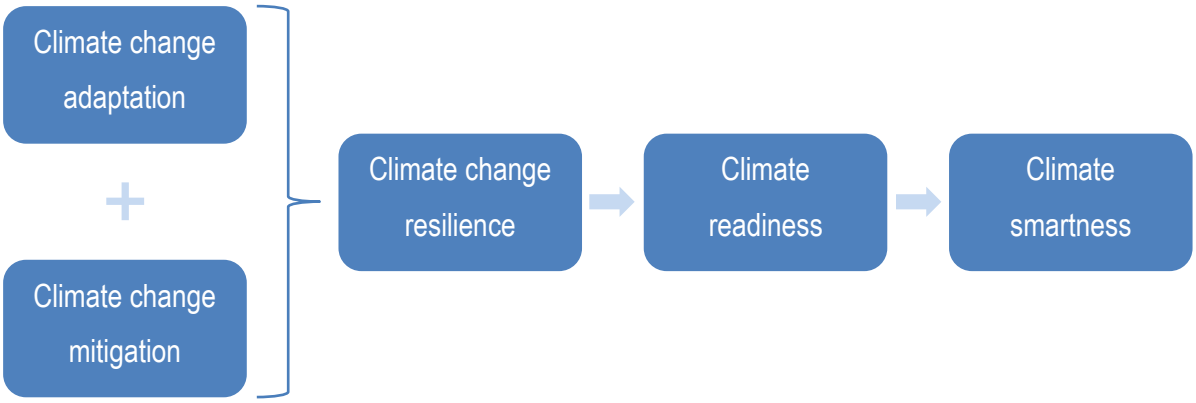

Figure 1: Climate crisis response concepts and their relationship to each other.

2.3 Systems thinking

2.3.1 Defining systems thinking

If systems thinking is going to be the lens through which the connections between the education system and climate change will be examined, it is imperative to have a primal understanding of what is meant by it. Discussing systems thinking almost inevitably starts with Donella Meadows, whose posthumously published work "Thinking in Systems: A Primer" is widely regarded as a seminal work in the discipline of systems thinking. While Meadows does not provide a formal definition of systems *thinking*, she does present a good starting point by clearly defining a *system* as "a set of elements or parts that is coherently organised and interconnected in a pattern or structure that produces a characteristic set of behaviours, often classified as its "function" or "purpose" (Meadows, 2008)." She emphasises that a system thus must consist of three kinds of things: *elements*, *interconnections*, and a *function* or *purpose*. A system, therefore, is more than the sum of its parts. This is nicely exemplified by the following Sufi teaching story that Meadows uses in her book (2008, p. 12):

> *You think that because you understand "one" that you must therefore understand "two" because one and one make two. But you forget that you must also understand "and".*

To further explore what the *thinking* in systems thinking involves, we can turn to Barry Richmond. While the field of systems thinking has a long history – one could argue dating back to antiquity – it is only more recently with contemporaries like Richmond that the terminology of systems thinking has started to develop. As a graduate student of Jay Wright Forrester (the founder of System Dynamics) Richmond credited himself for coining the term "systems thinking" back in 1987. He shares: "I began using the name 'Systems Thinking' to describe what it was that "stood behind" the software. I was unaware of other uses of this name, and I liked where it put the emphasis – i.e. on the thinking!" (Richmond, 1994)

Like Richmond himself, others seem to be unaware of other uses of the term before him, so it can be assumed that he indeed invented the term. He explains what he means by it: "Systems Thinking is the art and science of making reliable inferences about behaviour by developing an increasingly deep understanding of underlying structure (Richmond, 1994)." He goes on to define "the art and

science" as being composed of a Paradigm and a Learning Method as shown in Figure 2 (Richmond, 1994, p. 7).

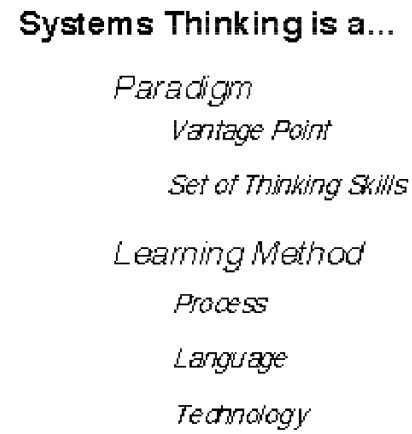

Figure 2: The components of systems thinking (Richmond, 1994, pp. 135-157)

Completely dissecting Richmond's definition would lead too far for the purpose of this research, but he does make an interesting analogy while explaining the 'vantage point' which is worth mentioning, as it can help to significantly increase a person's understanding of his reasoning: "People embracing Systems Thinking position themselves such that they can see both the forest and the trees." (Richmond, 1994).

From Barry Richmond, we can jump to Ross Arnold and Jon Wade, who identified the lack of a complete, widely recognised definition of systems thinking that can be shared by the systems community. Their solution comprises of a review of the literature on systems thinking and then applying systems thinking itself to this review. Their literature review starts with Richmond's (1994) definition, and further includes the definitions of Senge (1990), Sweeney and Sterman (2000), Hopper and Stave (2008), Kopainsky et al. (2011), Squires et al. (2011) and finally also Jay Forrester's non-definition (1994).

Through comparing these definitions, Arnold and Wade can identify common elements which include interconnections, the understanding of dynamic behaviour, systems structure as a cause of that behaviour, and the idea of seeing systems as wholes rather than parts (2015). They argue that "these are the components of which systems thinking is *made*, but the previous authors have neglected to detail what systems thinking *actually is* and *does*." Referring back to Richmond's axiom to focus on both the forest and the trees, Arnold and Wade claim that the previous authors "have

focused on either the forest or the trees." Their solution is to define systems thinking *as a system*, leading to the following definition: *"Systems thinking is a set of synergistic analytic skills used to improve the capability of identifying and understanding systems, predicting their behaviours, and devising modifications to them in order to produce desired effects. These skills work together as a system."* (Arnold & Wade, 2015) This definition is further elaborated in terms of its content with the following elements:

1. Recognising interconnections
2. Identifying and understanding feedback
3. Understanding system structure
4. Differentiating types of stocks, flows, variables
5. Identifying and understanding non-linear relationships
6. Understanding dynamic behaviour
7. Reducing complexity by modelling systems conceptually
8. Understanding systems at different scales

Arnold and Wade (2015) conclude that "this definition can be used for systems thinking educational efforts, systems science, and a myriad of other disciplines which require the use of critical systems understanding and intuition."

2.3.2 Systems inquiry

According to Systems Innovation Network – or Si Network – systems inquiry is intending to comprehensively map and understand a system, particularly a complex system. It takes a more holistic approach, which means its primary goal is to get an overall view of how the system works and which the most important factors are to be taken into account before analysing the system in more detail (Si Network, n.d.). This concept is nicely in line with the rationale for this thesis, making it a fitting approach for the theoretical framework.

Si Network breaks up systems inquiry into four sections:

1. System model
2. Systems mapping
3. Actor maps
4. Leverage points

The first section, system model, is about understanding what systems are, what they are comprised of, and identifying key concepts in systems such as elements (or nodes), interconnections, purpose or function, etc. This largely congregates with the previous section of this thesis in which systems thinking definitions were explored. In the next subchapters, this thesis will therefore assume that the idea of the 'system model' is already addressed and will continue with the remaining three sections of systems inquiry.

2.3.3 System mapping

Words and sentences have their limitations and discussing systems thinking requires additional language formats to do it righteous. Meadows (2008, p. 4) explains:

> *"I have made liberal use of diagrams and time graphs in this book because there is a problem in discussing systems only with words. Words and sentences must, by necessity, come only one at a time in linear, logical order. Systems happen all at once. They are connected not just in one direction, but in many directions simultaneously. To discuss them properly, it is necessary somehow to use a language that shares some of the same properties as the phenomena under discussion."*

Consequently, systems thinkers have a myriad of tools at their disposal to do so. System mapping tools allow systems thinkers to visually present what can be difficult or impossible to describe in words. Founder of the Unschool of Disruptive Design Leyla Acaroglu explains that "systems mapping tools enable an exploration of the system, communicate understanding, and enable the identification of knowledge gaps, intervention points, and insights. As systems thinking requires a change in our perception of the world around us, we need to learn the dynamics and interconnectedness of the systems at play to create a new multidimensional thinking framework (Acaroglu, 2017)."

Si Network reiterates these ideas by stating that mapping leads to a more thorough understanding of the structure of a system. They describe systems mapping as a modelling exercise aiming to expose and clarify underlying relationships and structures of a complex system (Si Network, n.d.). The organisation provides four reasons why systems mapping is helpful (directly quoted from Si Network, n.d.):

1. Systems maps help to create a holistic view, showing the system as a whole.

2. The underlying structure of a system is revealed and can be analysed by identifying and mapping linkages.
3. The visual representation of a system helps to create a shared understanding and perspective.
4. Points of intervention can be identified and agreed upon.

While 'showing the system as a whole' is indeed an important intent, it needs to be nuanced by the notion that "all models are simplified versions of the real world" (Meadows, 2008) because most systems do not have real boundaries and "everything is connected to everything else, and not neatly (Meadows, 2008)." Yet, in order to keep this process comprehensible, it is unavoidable to simplify and draw artificial boundaries.

To create systems maps, Acaroglu (2017) starts with a 'cluster map', following a process she outlines in four steps:

1. In the middle of a page, write a topic, question, or arena.
2. Add nodes (elements within the system) through free association. As everything is interconnected, there are no right or wrong words or ideas here.
3. Connect the nodes and draw the relationships between the nodes.
4. Gain understanding and identify potential intervention points.

While that process of free association serves the nature and complexity of systems thinking, it does not serve an academic methodology that needs to be controlled and replicable. As will be described in the methodology section of this thesis, a more systematic process of literature review will be followed, upon which the components of Acaroglu's process (identifying elements, connections, and insights) will be applied.

2.3.4 Actor maps

What is already implicitly embedded in Acaroglu's process, but merits a separate step in the systems inquiry approach, is to explicitly think through the stakeholders that are involved in the system that is being inquired. To facilitate this, Si Network advocates the use of actor mapping. Actor maps are used to show which individuals and organisations partake in a system and how they relate to

each other. The goal of actor mapping is to better comprehend the values, models, incentives and dynamics in the system (Si Network, n.d.).

Continuing to explain why actor maps are useful, they identify six reasons (directly quoted from Si Network, n.d.):

- Involvement: Actor maps help to recognize who will be affected by a change process in the system and thus who needs to be involved.
- Opportunities: Actor maps help to expose opportunities for alliances and collaboration and help to recognize potential points of conflict.
- Identify Gaps: Actor maps help to identify gaps in the flow of information or resources as potential intervention points.
- Communications: Actor maps help to understand the mental models and values of actors in the system, and thus tailor communication towards them.
- Explore Perspectives: Actor maps help to build up a better understanding of the system by looking at it from the different perspectives of the stakeholders.
- Adoption: Actor maps help to understand how an adoption process may take place by identifying who would be likely to resist or promote change in the system.

To create (or embed) an actor map, the idea is to list all the stakeholders in a system by reflecting on who is involved. Consideration can be made for those who are directly or indirectly involved. Profiles of the stakeholders can be created, and connections can be drawn between them. Those connections can represent financial exchange, communications, agreements, etc (Si Network, n.d.).

2.3.5 Leverage points

The final step in system inquiry is finding the places in the system where to intervene. Those places are known in systems thinking as leverage points. Donella Meadows introduced the idea of leverage points in a paper published by The Sustainability Institute in 1999. Meadows (1999) defines leverage points as “places within a complex system (…) where a small shift in one thing can produce big changes in everything.”

Identifying leverage points is tempting and appealing. They are points of power, instigating change in the structure of systems so that more desirable and fewer undesirable outcomes are produced (Meadows, 2008). Paraphrased by Si Network, leverage points have the potential to have large and lasting influence with minimal effort (n.d.).

But leverage points are often not intuitive to identify, and even if they are, they are often pushed in the wrong direction, making problems they are trying to solve even worse (Meadows, 1999). That being said, Meadows does identify a list of 12 points to intervene in systems, ranking in increasing order of effectiveness. To keep this list understandable with the limited systems theory that has been provided in this theoretical framework, the adapted version from Si Network with shortened and simplified language will be used (n.d.):

12. Quantitative parameters
11. Buffer stability
10. Material flows
9. Length of delay
8. Negative feedback
7. Positive feedback
6. Information flows
5. Change rules
4. Alter structure
3. Change goals
2. Alter mindsets
1. Transcend paradigms

It should be noted, as done by Meadows (2008, p. 201) herself, that this list "is not a recipe for finding leverage points. Rather, it is an invitation to think more broadly about system change."

As stated, this list ranks the leverage points in increasing order of effectiveness. It also shifts from more observable and superficial phenomena to more and more abstract constructs such as structures, goals, mindsets, and paradigms. To facilitate this thinking in different levels, systems thinkers often make use of the iceberg model. This model visually illustrates these various levels of abstraction "from observable events to the underlying patterns that generate them, to the supporting structures, and finally the mental models used in a system" (Si Network, n.d.), as shown in figure 3.

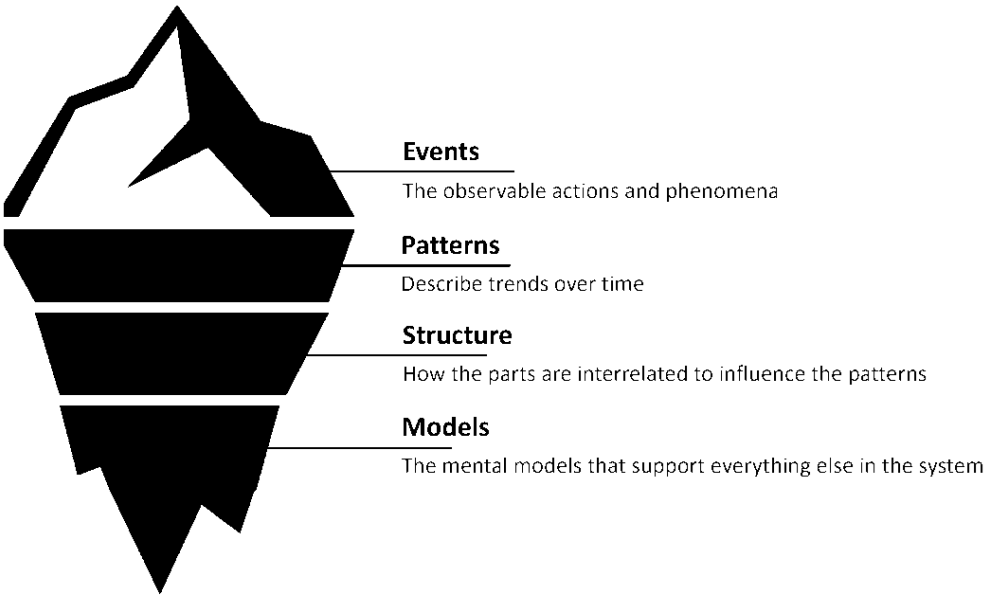

Figure 3: The iceberg model (Si Network, n.d.)

Monat and Gannon (2015) agree that the iceberg model is a core element of systems thinking and that the model shows that systemic structures and mental models – which are frequently concealed – cause events and patterns that are more easily observable. Interestingly, they modify the model to distinguish natural systems from human-designed systems, which applies to the exploration of this thesis which deals with both a natural system (i.e. the climate system) and a human-designed system (i.e. the education system). Whereas structures are always self-organised in natural systems, they can be either self-organised or designed in human-designed systems. The models that support all other things in the system are defined as physical and chemical forces in natural systems, and as mental models in human-designed systems. Figure 4 shows these differences between natural systems and human-designed systems according to Monat and Gannon (2015):

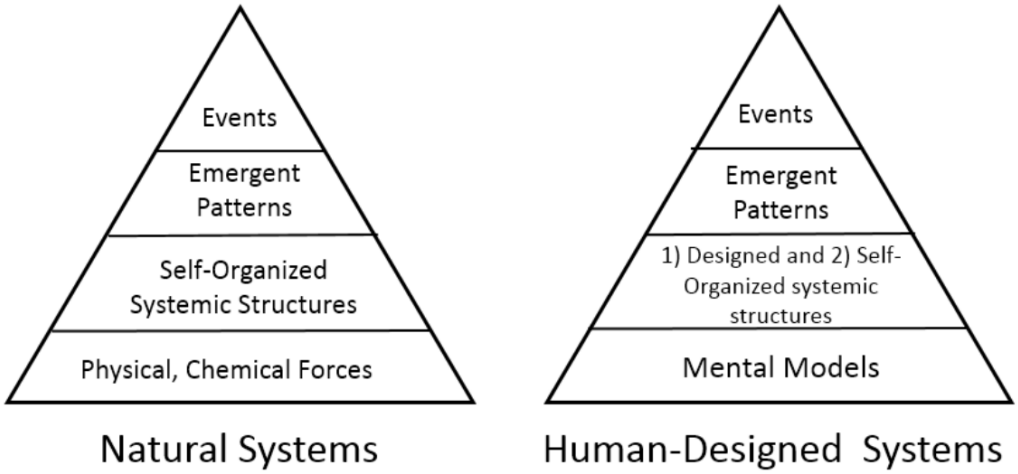

Figure 4: The iceberg model applied to natural versus human-designed systems (Monat & Gannon, 2015, pp. 11-26)

Armed with this framework of systems thinking skills and the systems inquiry approach, the integrative research review methodology, which will be introduced in the following chapter, will inform the mapping of the interconnectedness between the global education crisis and the climate crisis, and initiate the identification of leverage points to intervene in this vastly complex system of crises.

3 METHODOLOGY: INTEGRATIVE RESEARCH REVIEW

As the literature review for this thesis did not only serve the purpose of building a foundation of existing knowledge to relate this research to but also doubled as the actual research methodology, a quality literature review was imperative to the success of this work. The aim was to conduct a literature review that adheres to the criteria of depth and rigour, replicability, and usefulness (Snyder, 2019, p. 338).

The process was transparently documented and followed the basic four steps as outlined by Snyder (2019):

1. Designing the review
2. Conducting the review
3. Analysis
4. Writing up the review

This process is a composition of and shaped by a number of different standards and recommendations that are suggested to guide literature reviews (e.g. Liberati et al., 2009; Tranfield et al., 2003; Wong et al., 2013).

This literature review examined the existing reports and research on the causes, impacts, and current solutions for the global education crisis and the climate crisis and analysed the ways in which systems thinking can be applied to approach both crises and their interconnectedness. With this review, the author aimed to contribute to the body of knowledge by constructing a living systems map that visualises and operationalises the interconnectedness of both crises. The specific purpose of this review was to map out how the education crisis and the climate crisis are interconnected and which opportunities for positive impact on aspects of either or both crises emerge from this mapping.

To find relevant input for this living systems map, the author used a small-scale integrative literature review as the research methodology. An integrative literature review is “a form of research that reviews, critiques, and synthesizes representative literature on a topic in an integrated way such that new frameworks and perspectives on the topic are generated (Torraco, 2005).” This method matched with the aims of this research, i.e. to review the literature on the global education crisis, the climate crisis, and their interconnectedness, with the intention to apply a systems thinking

framework to generate new perspectives and insights on this interconnectedness between both crises.

Toronto and Remington (2020) point out that resources on how to conduct a well-done integrative review are rather limited and/or outdated, with significantly different ideas on how to conduct and publish this type of review, and they tend to lack crucial systematic procedures to assure rigour and reduce bias. One of the most recognised authors providing guidelines on integrative reviews is Torraco (2005, 2016), whose works distinguish between integrative literature reviews that address mature topics versus new, emerging topics, claiming that features of a review vary based on how mature the subject matter is. Reviewing a new or emerging topic is more likely to result in an initial or preliminary holistic conceptualization of the topic (i.e. a new model or framework), whereas an integrative review of a mature topic will be more concentrated on critiquing and potentially reconceptualizing the knowledge base of a topic. Torraco (2005) acknowledges that topics and issues vary along an age continuum, and for the integrative review in this thesis the review blended features of both ends of the spectrum. On the one hand, both the global education crisis and the climate crisis as well as systems thinking are mature and well-established topics. All three components of the research questions are well-researched and can lean on an extensive body of knowledge. On the other hand, the application of a systems thinking lens to examine the interconnectedness between the global education crisis and the climate crisis is still an emerging conceptualisation. While there were relevant and valuable publications available, their number is still very limited and some of the most interesting resources were only just published during the timeframe of this thesis work.

Torraco (2005) concludes his reasoning by pointing out that readers anticipate seeing the information from the literature combined into a model or conceptual framework that presents a fresh perspective on the subject, regardless of whether the review addresses a mature or an emerging topic. That was indeed the intention of this work as well, which made an integrative literature review the appropriate choice for the research at hand.

3.1 Designing the review

With the research questions clearly identified and an overall review approach decided, a search strategy for identifying relevant literature was developed. Following the principles for an integrative literature review, the literature search needed to be "systematic in its approach and comprehensive, using two or more methods, such as the use of multiple electronic databases and ancestry and hand search (the task of searching through peer-reviewed journals) methods" (Toronto & Remington, 2020, p. 6).

Given the nature of the topics of the research, it was both unavoidable and convenient to use the specific databases of intergovernmental organisations such as the United Nations and its subsidiaries such as UNESCO, UNICEF, IIEP, World Bank, the Global Partnership for Education, and others, as the first type of databases.

A second type of databases that was consulted is that of global research organisations such as Brookings, NORRAG and RISE which have a reputation to be rigorous, integer, independent, and qualitative and have specific expertise in the topics at hand, which is represented in the organisations' governance, structures, commitments, and approaches. Beyea and Nicoll (1998) have compared the integrative review process to 'mystery writing' and 'detective work', given the process of selecting key references from vast and different sources. Combined with Meadows's (2008) notion that systems representations are always artificially bounded, this 'detective' approach of following leads and clues in a vast offer of global research organisations was indeed acceptable and appropriate.

Inclusion and exclusion criteria for resources that were used in this integrative review can be found in Table 1, together with the reasoning concerning all choices made.

Table 1: Inclusion and exclusion criteria for the integrative review and their reasoning

Criteria	Reasoning
Year of publication	Global intergovernmental organisations and research organisations usually publish a flagship report periodically (often yearly). For those reports, the most recent available version was used. For sporadic,

	thematic reports, the year of publication needed to be within the past 5 years to ensure the use of recent and still valid information. Given the notion that both crises are constantly evolving, information and data will be regularly updated in newer studies. An exception was made for older works that were found in the references of primary sources and deemed highly valuable or even critical for the completeness of this review.
Language of the article	Only works in English were considered in this review. Given the nature of the topics and their international dimension, it can be reasonably expected that all relevant research will be conducted or at least available in English.
Type of publication	The focus of this review was on thematic and flagship reports from intergovernmental organisations and global research organisations that provide comprehensive, qualitative, and easily accessible information on the topic of the research. Next to that, also journal articles, blog posts from reputable sources, webpages, and books that were found in the references of primary sources and deemed highly valuable or even critical for the completeness of this review can be included.
Quality appraisal	Flagship reports from intergovernmental organisations are by nature deemed of high quality and trustworthy. For global research organisations, only reputable organisations with a strong track record and expertise in one of the topics at hand were considered.
Type of organisation	For both intergovernmental organisations and global research organisations only organisations with an explicit focus on either education and/or climate were considered.

The choice to conduct a small-scale review and not a full-scale review was forced by the circumstances of having an individual researcher with a limited timeline of fewer than 6 months as opposed to having a team of two or more with a broader timeframe of 6-12 months, which is recommended by Toronto and Remington (2020). Still, this forced choice was acceptable due to the availability of flagship reports on the research topics from the main databases of intergovernmental organisations and global research organisations that offer comprehensive, qualitative, and easily

accessible information that is built on a much broader scope of works, which eliminated the need for the individual author to again review and assess that much broader scope of works. Secondly, the choice to still prefer an integrative review as a methodology rather than a narrative review was also prompted by its different purpose (synthesizing a new conceptual framework versus merely providing an overview) and its use of a systematic search methodology that allows for replication.

3.2 Conducting the review

To report the search of this small-scale integrative literature review, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guidelines (Moher et al., 2009) were used. The PRISMA guidelines aim to improve the quality and transparency in reporting and to reduce bias. The focus is on how to write the final review rather than on how each included piece of literature is evaluated. The use of the guidelines was visualised in a search flow diagram (see figure 5) that displays which literature was included and excluded and the rationale behind the decisions to include or exclude publications.

The search started by listing the complete United Nations System (United Nations, n.d.) to file all potentially relevant intergovernmental organisations. In addition to the UN 'umbrella organisation', there are six funds and programmes, fifteen specialised agencies, nine other entities and bodies, and eight related organisations. This resulted in a starting point of thirty-nine organisations to assess for inclusion. The assessment was made by checking the organisations' websites for an explicit mention of education and climate in the organisations' focus areas or site maps. Based on this criterion, twenty-nine organisations were excluded from the next step, ten organisations were included in the next step, and an additional three organisations emerged as relevant UN-related organisations to be included in the next step. This resulted in thirteen UN organisations being included for further review.

Parallel to scanning the UN ecosystem, a first batch of eight global research organisations that were deemed highly valuable or even critical for the completeness of this review were identified to be included in the next step, using the 'detective' approach of following leads and clues. Hence, a

total of fifty organisations were assessed (UN + research organisations), of which twenty-one proceeded to the next phase of the search, which was a publication scan. A list of organisations that were assessed can be found in appendix 1.

As described in the review design, the focus of this review was to be on flagship reports and thematic reports from intergovernmental organisations and global research organisations. Scanning the libraries, resources, and publications sections of the twenty-one included organisations resulted in a selection of forty publications that adhered to the inclusion criteria as outlined in table 1. A list of the included publications can be found in appendix 2.

After identifying which literature needed to be included in this small-scale integrative review, the author conducted a staged review. Using a system of pass/fail in which abstracts and content tables were analysed to scope the relevance of the publication, fifteen publications were excluded, two duplicates were removed and a total of twenty-three sources were retained for in-depth review.

The in-depth review comprised an analysis of the relevant sections of the reports and publications that were identified in the analysis of the content tables. In addition, a search action within the document using the most relevant keywords was added to minimize the risk of missing relevant information from parts of the documents that were not included in the in-depth review. This resulted in the selection of one hundred and sixteen sentences or paragraphs that explicitly noted a connection between education and climate and that therefore could be used as data points to inform the living systems map.

Figure 5 shows the PRISMA flow chart of the integrative review and captures the process that has been described above.

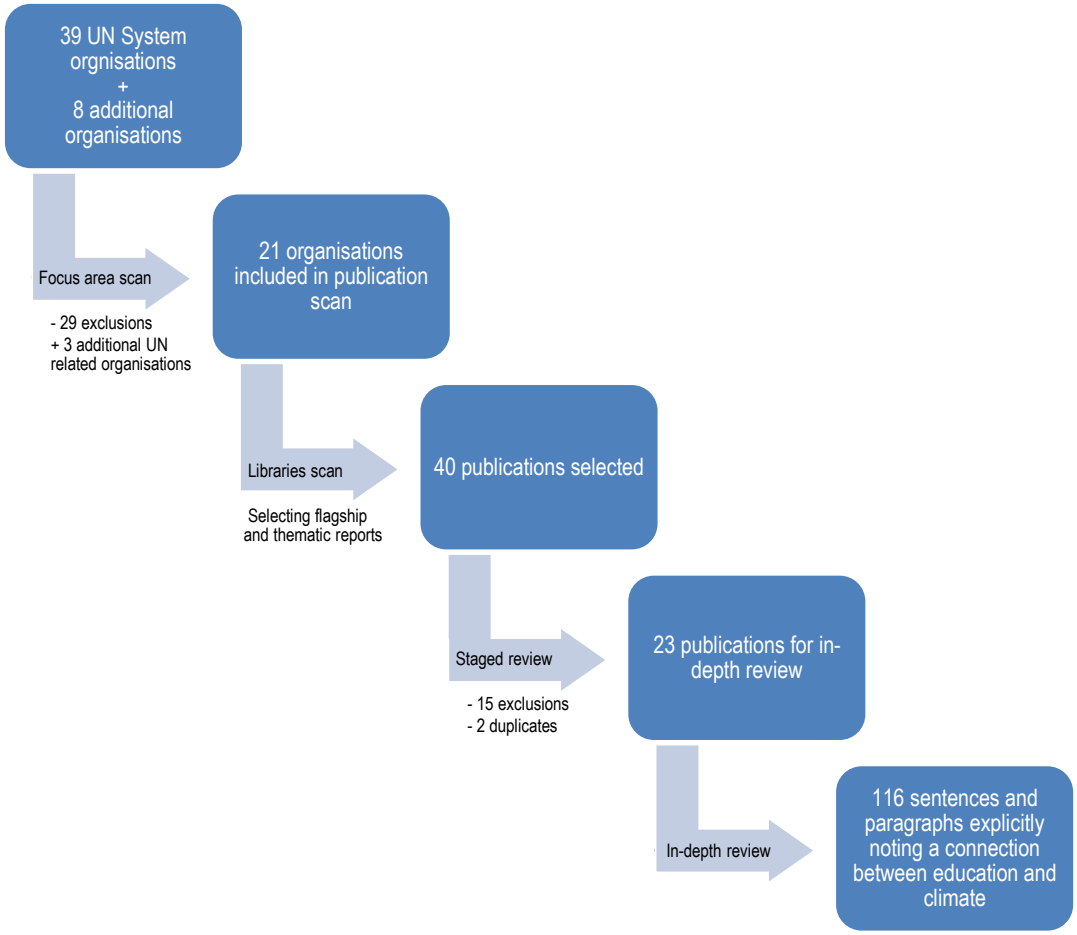

Figure 5: PRISMA flow chart of the integrative review process

3.3 Analysis

With the goal of this small-scale integrative review process being the creation of a living systems map, the author set out to map the one hundred and sixteen data points by applying a rigorous data analysis method. According to Torraco, this should allow the researcher to reorganize, combine, and integrate ideas and findings across the reviewed works in order to generate new insights into the topic of study (2016).

Following the guidelines presented by Toronto and Remington (2020), all the data points from the review were listed in a spreadsheet to create a data review matrix. Qualitative content analysis was selected as the most appropriate data analysis method because it is intended to recognise and

summarise informational content (Elo & Kyngäs, 2008). Three stages make up the analysis: preparing, organising, and reporting.

In integrative reviews, the preparation phase consists of reading the primary resources and extracting relevant data from the resources into the data review matrix (Toronto & Remington, 2020). In the organising phase of the process, the author identified the main climate element and the main education element that is mentioned in each data point. To keep the large amount of data points manageable and to create a clearly arranged systems map, the author organised the data points according to different levels at which they manifest. All data points were screened and marked as either mostly related to the global education crisis, or as mostly related to opportunities for a positive impact. To categorise the data points related to the global education crisis, the four manifestations of the global education crisis as outlined in the theoretical framework of this thesis were used (i.e. learning crisis, teaching crisis, infrastructure crisis and identity crisis). To categorise the data points related to opportunities for a positive impact, the existing 7-dimensions framework for action towards climate-smart education systems by the Global Partnership for Education (2023) was identified as a suitable, comprehensive, and user-friendly framework that emerged from the data collection and allowed for a clear arrangement in the systems map.

The last phase of the analysis was the reporting phase, which is covered by the results chapter of this thesis. The reporting consists of a detailed explanation of how the systems map was constructed and can be applied, including a testing and validation of the systems map in an illustrative case. This validation served to ensure that the living systems map can be used in future studies, policy work, and development work. To organise the data in a systems map, Kumu was used as a software tool that "makes it easy to organise complex data into relationship maps" (Kumu, 2023). Using excerpts from the newly created systems map as figures, a step-by-step reconstruction of the process is presented.

3.4 Writing up the review

With the process outlined above, the main ideas and themes from the literature were identified and analysed using the systems thinking lens as presented in the theoretical framework. Key concepts,

constructs, ideas, etc. emerged from the literature to inform the elements and connections in the living systems map.

The systems map was put to the test in an illustrative case, in which the education and climate context in Vietnam is used as a backdrop to identify how the map can be operationalised and prove its value. Vietnam provides a particularly interesting context for this test, as it is a country that is an outlier in the region when it comes to its education system. London (2021) describes how Vietnam earned this status of outlier due to its rapid increases in enrolment and impressive learning outcomes while maintaining a comparatively low level of income. While he acknowledges economic growth and historical and cultural elements as important contributors to this status as outlier, he adds that education is a national priority in Vietnam also thanks to its Leninist political system and thanks to high levels of accountability in its society. In relation to climate change, again Vietnam provides an interesting context. The Notre Dame Global Adaptation Initiative annual Country Index scores a nation's vulnerability to climate change as well as its readiness to improve resilience. On this index, Vietnam marks a high vulnerability score and a high readiness score, meaning that there still is a high need for adaptation and a great urgency to act, despite effective ongoing responses to climate change. The index positions Vietnam as the 58th most vulnerable country and the 93rd most ready country (Notre Dame Global Adaptation Initiative, 2021).

4 RESULTS

Upon finishing the qualitative content analysis of the selected data points from the reviewed publications, the author arrived at what was the central premise of this work, namely the creation of the living systems map. In what follows, the process of transforming the selected sentences and paragraphs into a living systems map is presented. Alongside this, an explanation of how to read, interpret and use the map is provided.

It should be noted, again, that the intention was not to create a final and static map as one single source of wisdom. Rather, the idea is to present key elements of, and connections between the education crisis and the climate crisis, and opportunities for leverage points in this system. As such, the living systems map is open-ended, never finished, and can always be edited, updated, and expanded with new data.

Finally, the systems map is applied in an illustrative case to test and validate the usability of the model. One element of the map was examined in the context of Vietnam, a country that is both an outlier in the region when it comes to its education system, as well as extremely vulnerable to the effects of climate change. This illustrative application of the new systems map examines if the map can help to uncover new insights related to this specific case.

4.1 A living systems map

From October 2022 to February 2023, GPE published a blog series about the role of education in addressing climate change. In the series, GPE features experts and thought leaders who share their knowledge on how education is pivotal to dealing with climate change, building the case for climate-smart education systems (Global Partnership for Education, 2022). The series consists of 18 blog posts as outlined in Table 2.

Table 2: A list of blog posts in the GPE series about the role of education in addressing climate change

Date	Title	Autor(s)
31/10/2022	How can education systems rise up to the climate challenge?	Sarah Breadmore, Raphaelle Martinez, Anna-Maria Tammi
02/11/2022	Framing the challenge: Education and the climate-environment emergency	Colin Bangay
07/11/2022	How Sierra Leone is betting on data to fight the impact of climate change on schools	Adama Momoh, Paul Atherton
08/11/2022	Meet Candida, Shingai and Paolo who continue learning in the aftermath of natural disasters	GPE Secretariat
09/11/2022	Carbon-smart schools mitigate climate change and improve learning	Catriona Forbes
14/11/2022	What aspects of education are eligible for climate finance?	Katharine Vincent
16/11/2022	How I fight climate change through education in Zambia	Clement Kaponda
21/11/2022	5 key takeaways from COP27 for the education movement	Sarah Beardmore
28/11/2022	Multilaterals, climate change and education: Emerging options for action	Camilla Helgo Fossberg
30/11/2022	Fighting for climate justice means fighting for gender equality	Christina Kwauk, Natalie Wyss, Lucina Di Meco
05/12/2022	Indigenous women in STEM are in a unique position to stop climate change	Leticia Tituana
07/12/2022	Planning is the starting point for climate-resilient education systems	Leonora MacEwen, Jean Claude Ndabananiye, Diana Ortiz, Thalia Séguin, Mathilde Tréguier
13/12/2022	The critical role of assessment in creating climate-smart education systems	Desmond Bermingham, Jennie Chainey

19/12/2022	eCooking: Low carbon cooking for schools and other institutions	Anna Clements
27/12/2022	Towards a pedagogy for climate action	Fumiyo Kagawa, David Selby
09/01/2023	The UK's new approach to addressing girls' education, climate and environmental change	Camilla Pankhurst
01/02/2023	Climate change is threatening education financing: We are launching a joint effort to identify trends and solutions	Anna-Maria Tammi, Carly Munnelly
27/02/2023	What can the education sector do to adapt to the forthcoming impacts of climate change?	Jamie Proctor

The blog series served as a build-up to the presentation of GPE's working paper "Toward climate-smart education systems: A 7-dimension framework for action", which was released on 6 April 2023. This paper suggests a framework of seven dimensions to take advantage of possible points to intervene in education systems and address the gaps that they bear, with the intention to increase the awareness that education can be resilient and relevant in the face of the climate crisis (Global Partnership for Education, 2023).

The GPE working paper was part of the publications included in the integrative review, and the 7-dimensions framework emerged as a suitable, comprehensive, and user-friendly framework that combined well with the four manifestations of the education crisis that were presented in the theoretical framework. The combination of these two frameworks captured different layers and perspectives of the global education crisis, allowed for a clear arrangement of data points in the systems map, and guides the user from crisis manifestations over action dimensions towards the opportunities for leverage points. In the following paragraphs, the construction of the map is presented in detailed steps, explaining the process of creating and organising the different types of elements and their connectedness. The explanation will make use of visual excerpts from the map which can be found in its totality on Kumu at https://www.kumu.io/verrecht/thesis.

Central to the map are the two crises in question, as seen in figure 6. The two crises are connected by a double-sided arrow, signalling a mutual connection. All elements and connections in the map are clickable and doing so will reveal a description of which data points from the integrative review were used to inform this element or connection. In this case, selecting the double-sided connection

arrow reveals a list of nineteen data points from ten different publications that were part of the review, as can be partially seen in figure 7.

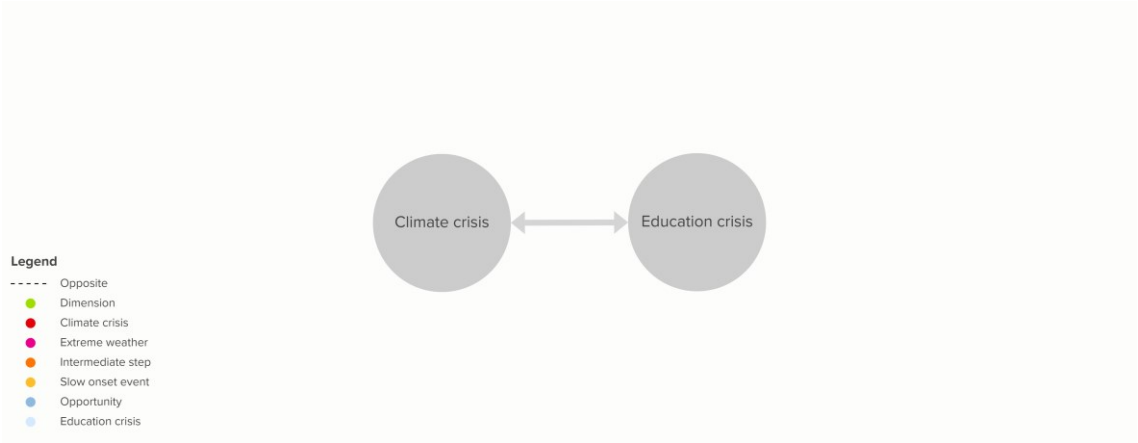

Figure 6: A focused view of the two central elements and their mutual connection.

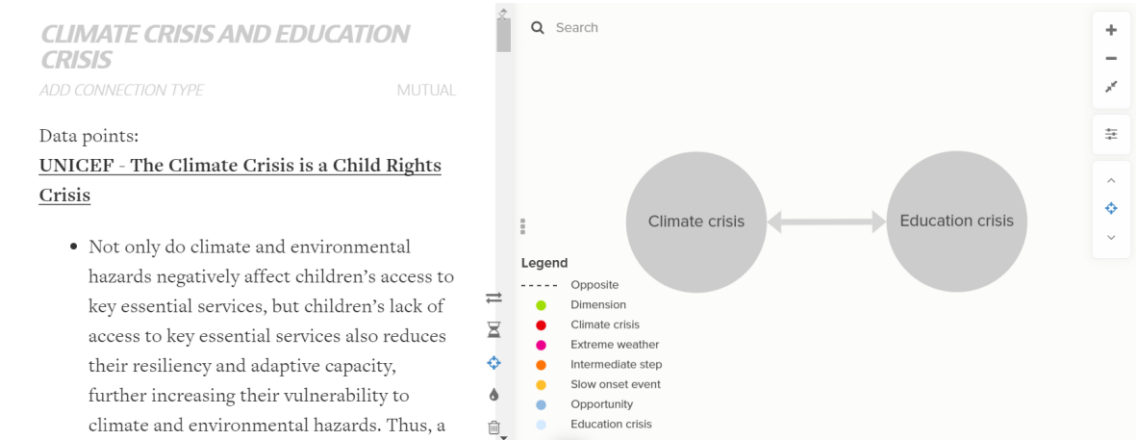

Figure 7: A partial view of the description of the mutual connection between the climate crisis and the education crisis.

When expanding the focus view in Kumu, a second layer of elements and connections is revealed (see figure 8). This layer splits up each crisis into different components. On the left side, the climate crisis can manifest as either extreme weather, or as slow onset events. These two elements were informed by the GPE working paper "Toward climate-smart education systems" (Global Partnership for Education, 2023), as again can be retrieved by clicking on either element. On the right side, the global education crisis was differentiated into its four different manifestations that were introduced in the theoretical framework. Clicking on each of the four elements summons a description of the element, taken from the theoretical framework, and, where relevant, data points from the integrative review were added. This layer introduces the colour codes that are used in the map and can be

seen in the legend. The climate crisis elements are marked in red; the education crisis elements are marked in light blue.

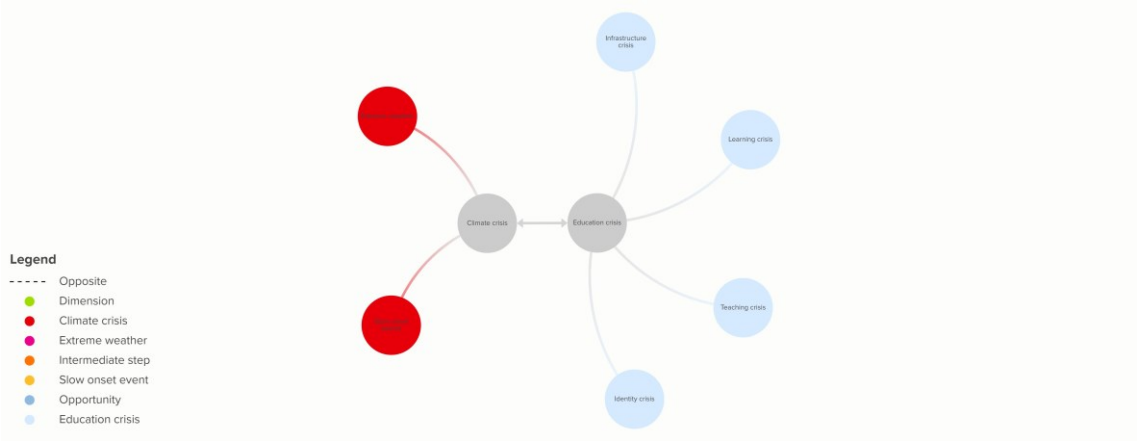

Figure 8: A focused view of the different manifestations of the two crises.

To further explore the systems map, the user can now turn their attention to the climate crisis side of the map (figure 9). This side further details which forms of 'extreme weather' and 'slow onset events' were mentioned in the literature. Floods, heatwaves, storms, cyclones, and droughts are marked magenta as extreme weather. Ongoing aridification, increasing temperatures, and deforestation are marked orange as slow onset events.

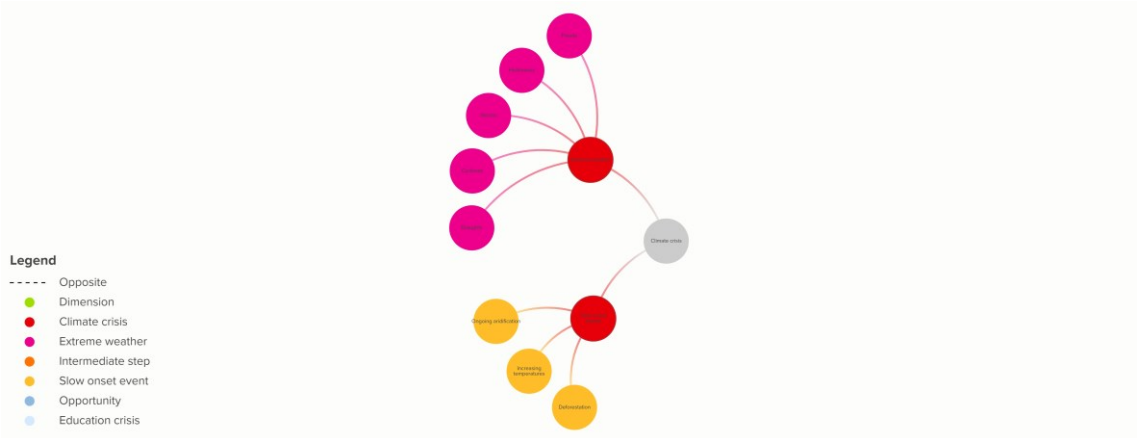

Figure 9: A focused view on the climate crisis elements.

On the other side, the education crisis side, the map further expands from the four different manifestations of the global education crisis into the seven dimensions of the GPE framework: data and evidence, policy and planning, coordination, finance, infrastructure, teaching and learning, and schools and communities. These dimensions are marked in green. Figure 10 shows what this looks like on the systems map. As the map expands with more elements, naturally more connection lines

occur as well. These connection lines were informed by the data points in the descriptions of the different elements. For each of the seven dimensions, it is noted which data points from which publication for the integrative review related to the dimension. Where relevant, a reference to the GPE blog series was included as well.

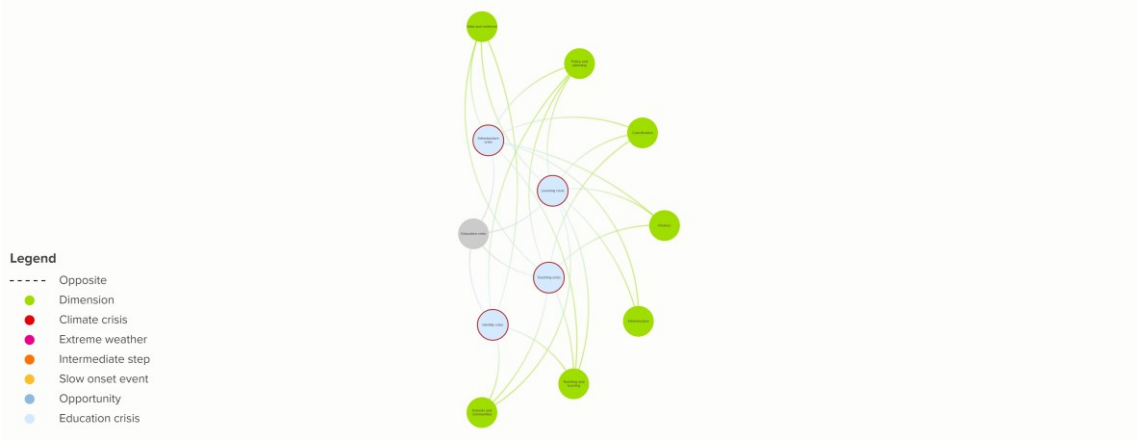

Figure 10: A focused view on the four different manifestations of the global education crisis and the seven dimensions of the GPE framework.

Throughout the qualitative content analysis, a myriad of attention points or opportunities for positive impact emerged from the data points. These opportunities were captured in the systems map in dark blue and anchored to the seven dimensions of the GPE framework for action towards climate-smart education systems, as seen in figure 11. The current list of opportunities for leverage points can be found in table 3 and contains 36 items.

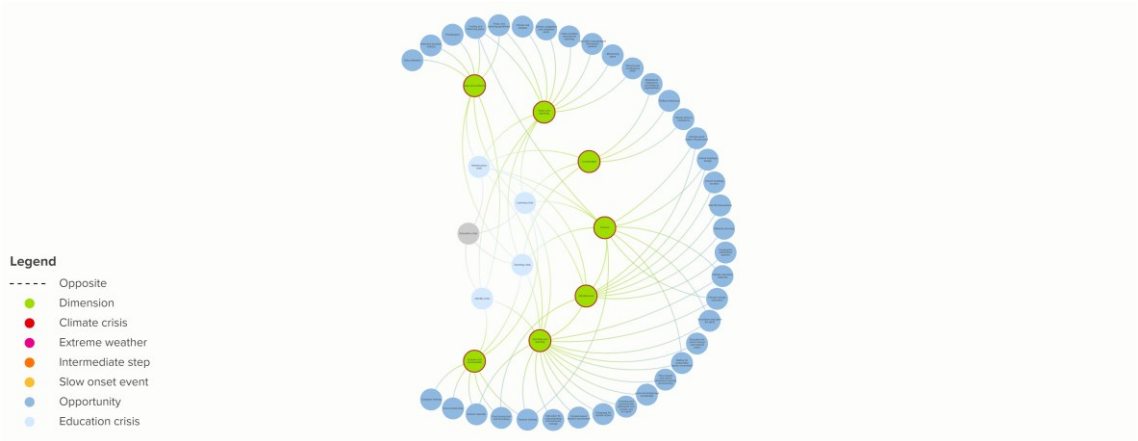

Figure 11: A focused view on the opportunities for leverage points.

Table 3: A list of the opportunities for leverage points.

Item	Opportunities for leverage points
1	Context-based student assessment
2	Climate education materials
3	Climate change education
4	School leadership
5	School building location
6	Data collection
7	Policy and planning guidelines
8	School-level contingency plans
9	Climate risk analysis
10	Prioritisation
11	School building design
12	Secondary education (for girls)
13	Climate adaptation and mitigation plans
14	Place-based and nature-immersive learning and teaching
15	Skilling for sustainable “green economies”
16	Caregiver training
17	Informed decision-making
18	School calendar
19	Teacher training
20	Political advocacy
21	Crisis-sensitive educational planning
22	Multilateral institutions and bilateral organisations
23	Education for social change and political action
24	Retrofit interventions

25 Costing and financing plans

26 Learning and teaching that addresses eco-anxiety and eco-grief

27 Local and indigenous knowledge

28 Material sourcing

29 Monitoring plans

30 Geographic information systems

31 Food production and eCooking

32 Climate finance institutions

33 Pedagogy for climate action

34 Education management information systems

35 Education for understanding and behaviour change

36 Climate-smart public infrastructure

These opportunities bring the map to fruition and paint a complete (but not final) picture, offering options and data-driven guidance to the future user of the map. Figure 12 shows a complete view of the systems map in its current state.

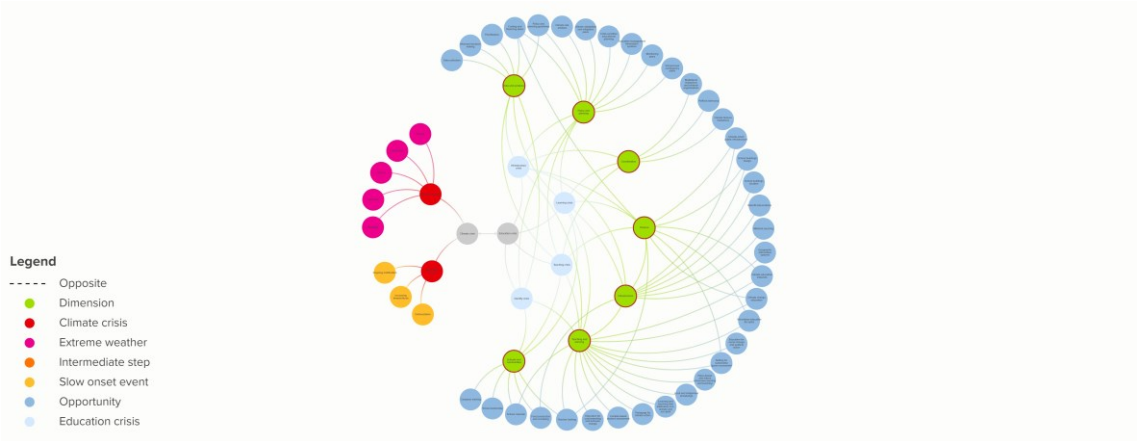

Figure 12: A complete view of the systems map, dated 3 July 2023.

Upon opening the map on Kumu, the user can interact with the map, e.g. by hovering over an element to fade out non-related elements and connections which gives a more focused representation of elements and connections related to the selected element. Figure 13 exemplifies such a

focused view of the element *Finance*. This shows that the finance dimension is directly related to the infrastructure dimension, as well as to the learning crisis, the teaching crisis, and the infrastructure crisis. It also shows that the finance dimension is directly connected to the following attention points or opportunities: costing and financing plans, climate-smart public infrastructure, school building design, climate education materials, climate change education, secondary education (for girls), skilling for sustainable "green economies", and teacher training.

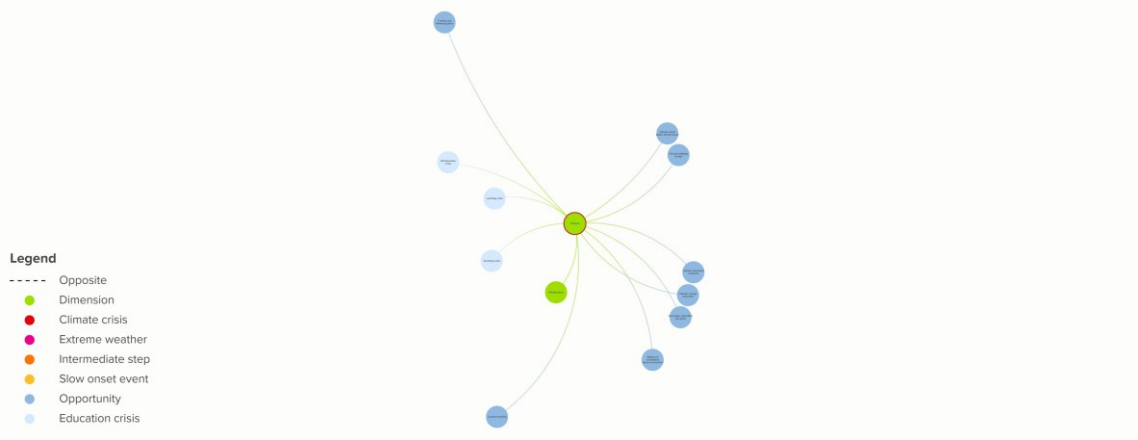

Figure 13: A focused view on the element 'finance'.

Undoubtedly, there are many more connections to be drawn and there may be many more elements to be added. This serves as a good example that the systems map is living and never-ending. The elements and connections that can be seen on the map in its current state are what emerged from this integrative review and qualitative content analysis. They are, however, by no means final, as new data and new insights can surface and can be added to the map.

4.2 Illustrative case: Vietnam

To further explore how the map can be used and interpreted, the author applied the map in an illustrative case. In this illustrative case, Vietnam's education system and climate situation are used as clearly defined contexts to which to operationalise the map. This process simultaneously served as a test to showcase and validate the usefulness of the map.

Vietnam has been identified as "one of the top five countries in the world to be the most vulnerable to climate change" (USAID, 2022). Its 3.260 kilometres of coastline hosts large cities and important production sites yet sits highly exposed, making sea-level rise a substantial risk (World Bank Group,

2022). It is not only a future problem for the coastal areas, however. The effects of climate change are already felt today and also inland. On 7 May 2023, the highest-ever temperature in Vietnam was recorded at 44 degrees Celsius, in the northern province of Thanh Hoa (BBC News, 2023). In 2020, an exceptionally intense seasonal monsoon and several tropical storms brought prolonged heavy rainfall to the centre of Vietnam, resulting in numerous large-scale floods and landslides. On top of the tragic human losses, significant damage to infrastructure was reported, including 1.569 schools that were affected (International Federation of Red Cross and Red Crescent Societies, 2020).

The effects of climate change in Vietnam are intensifying, but not new. The same can be said for the government's commitment to mitigate and adapt to climate change. In 2021, a National Green Growth Strategy for 2021-2030 with a vision towards 2050 was launched, building on, amongst others, a resolution from 2013 on 'proactively adapting to climate change, stepping up the management of natural resources and protecting the environment' (Government of the Socialist Republic of Viet Nam, 2021). This National Green Growth Strategy includes a number of tasks and solutions for the different ministries. For the Ministry of Education and Training (MOET), the tasks are defined as follows:

> *Formulate and deploy training programs, integrating content related to green growth into educational activities at different levels of education; raise the awareness of teachers and educational management cadres about the role, significance and orientation of activities to actualize green growth, strengthen the coordination between schools, families and society so that green lifestyles and green-oriented consciousness could take shape in schools and in society.*

The solutions involving the education sector are defined as follows:

> *- Attach importance to education on soft skills, strengthen coordination between schools, families and society so that a green-oriented consciousness and a green, civil, contributive and innovative lifestyle could take shape.*
>
> *- Raise the capabilities and the knowledge related to green growth for teachers and educational management cadres; integrate content related to green growth into the curriculum and the educational activities at different levels of education; establish higher education programs (providing them with their own program codes) to train human resources for green sectors; expand the deployment and construction of safe, green, clean and smart school models.*
>
> *- Prioritize investments into the infrastructure of schools and vocational training facilities in accordance with green standards and criteria in order to serve the tasks of training and teaching.*

- Proactively cooperate in research, education and training, thereby creating favourable conditions for enterprises and research institutions in terms of access to advanced technologies; carry out technological transfer and develop human resources for green economic sectors.

In each of these fragments from the National Green Growth Strategy, several elements from the systems map can be recognised, such as education for understanding and behaviour change, education for social change and political action, pedagogy for climate action, teacher training, skilling for sustainable 'green economies', climate-smart public infrastructure, etc.

To test and validate the usefulness of the living systems map, the solution that is defined as "Prioritize investments into the infrastructure of schools and vocational training facilities in accordance with green standards and criteria in order to serve the tasks of training and teaching." was used as an example. The element 'infrastructure' in the systems map can be recognised in this description. When applying a focused view on the element 'infrastructure', this results in the identification of all other elements in the systems map that are directly linked to 'infrastructure' and that therefore are relevant to consider when making decisions about infrastructure. In the current version of the systems map 'infrastructure' links directly to 'finance' and 'teaching and learning' as dimensions from the GPE framework, to 'infrastructure crisis' and 'learning crisis' as manifestations of the global education crisis, and to 'climate-smart public infrastructure', 'school building design', 'school building location', 'retrofit interventions', 'material sourcing', 'geographic information systems', and 'food production and eCooking' as opportunities for leverage points. Figure 10 shows how this is visualised in the systems map.

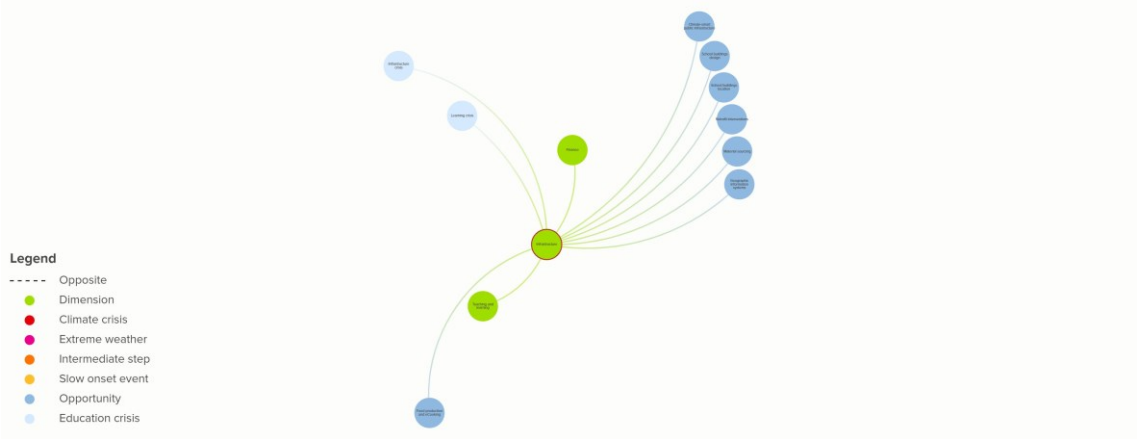

Figure 14: A focused view on the element 'Infrastructure'.

There are a number of possible ways to work with this information, depending on what the user wants or needs. This focused view on infrastructure can trigger decision-makers to think about the consequences decisions related to infrastructure can have on another dimension such as teaching and learning. It can inform them how infrastructure relates to the learning crisis and impact their decision-making accordingly. It can inspire them to think about retrofit solutions or material sourcing when debating “investments into the infrastructure of schools and vocational training facilities in accordance with green standards”.

While these are all worthwhile uses and outcomes in and of themselves, the real benefit of this systems map becomes clear when users embark on their own journeys across multiple layers and connections in the map. In the example at hand, school building location and school building design can emerge as leverage points to which decision-makers want to pay specific attention, since these elements can be part of the solution for the infrastructure crisis and the learning crisis. If the user then decides to shift their focus, they can find additional connections and data points to further inform their reasoning. Both the infrastructure crisis and the learning crisis link to the ‘data and evidence’ element, which in turn brings ‘data collection’, ‘informed decision-making’, ‘prioritisation’, ‘costing and financing plans’ and ‘policy and planning guidelines’ as attention points and opportunities into the picture.

To conclude, in this illustrative case that was used to explore the usefulness of the living systems map, it becomes apparent that the map not only helps users to identify direct links to the element of focus, but it also encourages users to think across multiple layers (crises, dimensions and opportunities) and to follow connections to new elements. This guides them to consider additional attention points and opportunities that are perhaps only indirectly related. The map served its purpose as a thinking tool for the user by making them consider possible implications related to their starting point, which was to “prioritize investments into the infrastructure of schools and vocational training facilities in accordance with green standards and criteria”. It also served its purpose to allow opportunities for leverage points to emerge, both directly related and indirectly related to the starting point.

5 DISCUSSION

The central premise of this thesis was to explore the interconnectedness between the global education crisis and the climate crisis (RQ1) and, arguably more importantly, how this exploration can inform leverage points to intervene in these crises (RQ2). Systems thinking was used as the lens to facilitate this exploration, and systems mapping served as the tool to translate the exploration into a living systems map. A small-scale integrative research review of twenty-three flagship reports and other high-level publications by intergovernmental organisations and global research organisations surfaced one hundred and sixteen data points that were subjected to a qualitative content analysis. This analysis resulted in the living systems map that can be consulted online at https://www.kumu.io/verrecht/thesis and consists of fifty-nine elements, organised in colour-coded semi-circles to enable easier identification and navigation in the map.

To transcend the theoretical review and showcase and validate the practical application of the living systems map (RQ3), an illustrative case was elaborated in which the map was operationalised in the context of Vietnam. This illustrative case demonstrated the versatility of the map both by identifying direct links towards attention points and opportunities for leverage points, as well as by instigating mental journeys across multiple layers to consider new connections and elements throughout that journey.

The living systems map answers the first research question but looks and functions differently from what the author had anticipated as it does not depict direct links between manifestations of climate change and elements of the global education crisis. All connectedness between the two crises is bundled in the central double-sided arrow. This choice was made for two reasons. First, adding separate connections between climate crisis manifestations and elements of the education crisis would have resulted in much more elements and connections on the map, and therefore would have created a more chaotic and less legible, i.e. less user-friendly outcome. Second, while the climate crisis is undeniably a complex and multi-layered phenomenon, the data points mostly referred to it in terms of ‘extreme weather’ or ‘slow onset events’ as the main forms of manifestation. This allowed for an easy funnelling of this side of the map, (as could be seen in figure 9, p. 38) and encouraged the decision to consolidate the interconnectedness between the two crises in one place. This decision in turn shifted the author’s (and inevitably also the user’s) focus towards the attention points and opportunities for leverage points on the education side of the map.

The education side of the map is constructed in a way that guides the user back and forth (and crisscross) from 'crises' over 'dimensions' to 'leverage points'. The first semi-circle, in light blue, is constructed with the four manifestations of the global education crisis that were introduced in the theoretical framework. While it became evident that all four manifestations are relevant and have direct links with the seven dimensions and their subsequent leverage points, it is noteworthy that the data points from the reviewed publications almost exclusively focused on the identity crisis. This can point to two things. On the one hand, it is possible that the education system's identity crisis holds the key, meaning that it has the highest probability to positively impact both the education crisis itself and the climate crisis when this identity issue is being addressed. Through education reforms, a new direction and purpose for the education system could indeed very directly contribute to solving the climate crisis as well, as a number of data points (and whole publications) suggest. Alternatively, it is possible that the three other manifestations (the learning crisis, the teaching crisis, and the infrastructure crisis) are underexposed in the literature when it comes to their likelihood to create opportunities to positively impact the climate crisis. Yet, as it goes with systems thinking, all four manifestations of the education crisis are interconnected between themselves as well and therefore should not be seen as islands or separate elements. Discussing about and investing in the identity crisis inevitably also addresses the three other crises, and vice versa.

Moving to the next semi-circle, the seven elements in green represent the seven dimensions framework for action toward climate-smart education systems. The publication of this framework by GPE in April 2023 coincided with the author's integrative research review. Given the similarities in aims and intentions, this framework proved to be most valuable in further structuring and organising the living systems map. A number of other frameworks or structures were available and considered, such as the five Priority Action Areas in the Roadmap for Implementing the Global Action Programme on Education for Sustainable Development (UNESCO, 2014), the Framework for Action for the implementation of SDG 4 (UNESCO, 2016), the eight interrelated themes in Special Issue 07: Education in Times of Climate Change (NORRAG, 2022), or the RISE Education Systems Diagnostic (Spivack et al., 2023), to name the most prominent ones. Despite being perceived as very valuable in their own right, none of these alternative options provided the same holistic angle as the GPE seven dimensions. Either they served a more narrowly defined purpose by focussing on a specific programme or they lacked practicality by being formulated in more abstract ways. The GPE seven dimensions offered the best of both worlds, being a well-balanced blend of high-level

formulation, comprehensive scope, and practical application, matching nicely with the direction the living systems map was evolving in.

In the outer circle of the map, the user will find the thirty-six opportunities for leverage points. These leverage points are structured around their connectedness to the seven dimensions and informed by the data points that were identified in the integrative review as well as by GPE's blog series about the role of education in addressing climate change (see table 2). Arguably, this outer circle is the most interesting part of the living systems map, as this is where the map transitions from a theoretically informed framework into a practically applicable tool, thereby answering the second research question of how the systems map can inform leverage points for its users. While undertaking a journey through the map, in these thirty-six elements users will find data-driven inspiration to focus their attention on when discussing and thinking about which actions to take, or when making decisions.

As demonstrated in the illustrative case, which also answers the third research question, the relevance of the map lies not only in identifying elements and connections but perhaps even more so in guiding its users in a thought process when applying the map. In the introduction, the author named governments and policymakers, actors in the international development sector, and future researchers as potential target audiences for this map. When these stakeholders, or others, apply the living systems map in their work, it can serve as a starting point to initiate diverse and holistic perspectives, which is relevant and perhaps even imperative when discussing global crises at a macro level. Next to being a starting point, the map can also serve as a tool to get unstuck. In ongoing discussions, research, or developments, obstacles will inevitably arise. At that point, an exploration of the living systems map can help to see things from different perspectives, take new viewpoints into account, and consider solutions, next steps or alternatives that may otherwise be overlooked. Finally, the map can quite literally lead the way for users that have a very specific objective. Whether someone wants to focus on one of the four manifestations of the education crisis to find action points that also positively impact the climate crisis, or someone wants to analyse how one specific action point links to other dimensions or manifestations or action points, the map can assist in doing so. These three use cases (being a starting point, being a tool to get unstuck, and being a guide for a specific purpose) make the map a versatile, relevant, and applicable instrument.

Ultimately, it is meaningful to refer back to the theoretical framework that portrayed the dynamics to address the climate crisis and how they relate to each other (see figure 1, p. 15). In this framework, the combination of climate change adaptation and mitigation is considered to lead to climate resilience, which in turn is a prerequisite for climate readiness. In addition to being climate-ready, systems can become climate-smart when they move beyond reacting to climate change and rather use the challenges it brings as opportunities to become part of the solution. The living systems map that is being presented in this work addressed exactly that. It informs which challenges the climate crisis presents to the education system, and which challenges the education system experiences internally. Then it guides the user of the map on how these challenges can be turned into opportunities to become part of a solution that addresses both the education crisis and the climate crisis. It is this guidance on turning challenges into opportunities that give the living systems map its most significant value.

As stated in the methodology, the premise of undertaking an integrative research review is to review, critique, and synthesize relevant literature to generate new frameworks and perspectives (Torraco, 2005). It can be argued that this work achieved both these goals. The living systems map provides a new framework for its users to think about the global education crisis and the climate crisis in a holistic and interconnected, i.e. systemic way. This framework, and more specifically the application of the framework, can offer new perspectives on both crises. It combines theoretical frameworks with practical applicability. It combines macro-level outlooks with specific actionability. In line with Torraco's (2005) expectations, users of the map can find insights from the literature synthesized into a new format that enables new vantage points and interpretations.

5.1 Limitations

While the systems map may give the impression to be comprehensive, it is important to acknowledge that it is not a final product. Inherently to the nature of systems thinking, the mapping of elements and connections in this map can be considered to be a never-ending process. It is largely dependent on where artificial boundaries are drawn, which elements and connections are included and which are not. When discussing the climate crisis, this could be reframed as 'planetary boundaries' (Steffen et al., 2015) which would lead to an even more comprehensive picture. In the theoretical framework on the global education crisis, additional or different sub-crises could be

identified like ‘governance crisis’ or ‘purpose crisis’. Therefore, adding new or more specific elements to the systems map may result in new connections and insights and perhaps even require a complete restructuring of the map.

Another important limitation to recognize is the scope of the integrative research review. As documented in the methodology, the author was conscious of his limited ability as a single researcher with a small timeframe. Despite having clear arguments to still opt for the integrative research approach and modifying it into a small-scale variant with a clearly documented systematic approach and a rigorous data analysis method, it nevertheless remains small-scale. This implies a high likelihood of missing relevant sources, publications, and data points, which could have led to different results and insights.

The construction of the living systems map is also subjected to certain limitations. As pointed out earlier, all the connections between the climate crisis and the global education crisis have been condensed into one double-sided arrow in the centre of the map. Although there were good reasons to take this approach, it must be acknowledged that this resulted in a less direct representation of this interconnectedness, which was one of the premises for this research. Additionally, in favour of useability, the researcher opted to not include a mapping of the actors in this systems map although that was identified as of significant importance in the theoretical framework on systems thinking.

In contrast to the three previous limitations, another critique that can be expected is that this living systems map can be perceived as being too complex with too many elements and connections. The map contains indeed a lot of information and finding a suitable way to present this information and make it digestible proved to be a challenging task. Although concessions were made (e.g. by condensing all the direct connections between the education side and climate side of the map into one double-sided arrow), the author also wanted to respect the fact that complex and multilayered issues deserve space and attention and that simplifying complex issues could undermine the whole purpose of this exercise.

Lastly, this work has been mostly focused on the context and the framework that systems thinking and systems mapping provide, and how this can be applied to the notions of the global education crisis and the climate crisis. What was less prevalent in this work is the actual content in this newly developed systems map. Apart from using the content to illustrate ideas, suggestions, and findings,

there is significantly more information available in the map that did not find its way into this document. It was beyond the scope of this work to include all the individual elements and connections of the map and the data points that informed them. While they can be consulted in the map itself, they are not all individually addressed in the results or discussion and a selection was made by focussing on the opportunities for leverage points.

That being said, it is essential to include the online systems map as an integral part of this work. With this map as the main output, and with the description of the results of this work, the author did manage to answer all three of the research questions in a satisfactory way.

5.2 Recommendations

Building on the notion that this work discusses a *living* systems map, there are a number of recommendations that can be made. First and foremost, it should be clear by now that this map is not a finished product. Therefore, all future users should feel encouraged to add data to the map and to add or suggest new elements and connections. Users should also feel encouraged to copy the map and tailor it to their specific needs.

Another recommendation is to zoom in on specific elements or connections of the map to conduct more targeted research on. There are a number of elements in the map that emerged as potential leverage points but that have few or no data points to further evidence this proposition. Future research on these specific elements, and their connectedness to the seven dimensions framework, the four education crisis manifestations, or the climate crisis could inform new insights and provide more robust evidence for the position and potential of the leverage points.

In line with the limitation that both the climate crisis and the education crisis could be reframed in different ways, the recommendation can be made for future researchers to first expand the frameworks that have been used in this map and, for example, add in other planetary boundaries or other manifestations of the education crisis to create an even more comprehensive picture. This should be done with consideration for the useability, however, which will always be a challenging and individual balance to pursue.

Alternatively, future studies could also opt to narrow the scope of the map to make it more specific. It can be relevant to further focus on one crisis manifestation or one of the seven dimensions and provide more data and narratives on how these elements specifically contribute to climate-smart education systems.

6 CONCLUSION

This thesis set out to apply systems thinking to explore the interconnectedness between the global education crisis and the climate crisis. In addition to identifying the elements and connections in a systems map on this topic, the results of this integrative research review also identified thirty-six potential opportunities for leverage points for governments and policymakers, actors in the international development sector, future researchers, and other potential users of the map to focus their attention on when working on solutions for either or both the education crisis and the climate crisis. These leverage points can assist the education system to evolve into a climate-smart education system that not only addresses its own pain points, but also contributes to solving the climate crisis. The newly developed systems map can be applied in a myriad of ways, ranging from being a starting point for discussions, over being a tool to get unstuck, into being a guide for very specific use cases. Ultimately, though, it is the facilitation of turning challenges into opportunities that gives this living systems map its most significant value.

At the onset of this work, the author stated the need to figure out how the education sector can play a role in addressing the climate crisis and fulfilling its premise of being the most powerful weapon we can use to change the world. A comprehensive, holistic framework that consolidates and captures a broad and neutral perspective and accommodates the complexity, scale, and evolving nature of the two crises was envisioned to respond to that need. With the living systems map that emerged from this integrative review, the author believes to have fulfilled this premise. Albeit the map turned out to look and work differently than anticipated, the current version serves its intended purpose very well. Based on this living systems map, practitioners can find support and guidance in exploring one of the most layered and complex challenges of our time. Future research can further finetune and elaborate the map to make it even more comprehensive, versatile, and evidence-based.

With the identification of these thirty-six opportunities for leverage points, the map empowers the notion that we can indeed solve the climate crisis and the education crisis together, as was put forward at the start of this journey.

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LIST OF ORGANISATIONS ASSESSED FOR ELIGIBILITY APPENDIX 1

IN THE INTEGRATIVE REVIEW PROCESS.

No.	Acronym	Name	Included
1	UN	United Nations	Yes
2	UNDP	United Nations Development Programme	Yes
3	UNEP	United Nations Environment Programme	Yes
4	UNFPA	United Nations Population Fund	No
5	UN-HABITAT	United Nations Human Settlements Programme	No
6	UNICEF	United Nations Children's Fund	Yes
7	WFP	World Food Programme	Yes
8	FAO	Food and Agriculture Organisation	No
9	ICAO	International Civil Aviation Organisation	No
10	IFAD	International Fund for Agricultural Development	No
11	ILO	International Labor Organisation	No
12	IMF	International Monetary Fund	No
13	IMO	International Maritime Organisation	No
14	ITU	International Telecommunication Union	No
15	UNESCO	United Nations Educational, Scientific and Cultural Organisation	Yes
16	UNIDO	United Nations Industrial Development Organisation	No
17	UNWTO	World Tourism Organisation	No
18	UPU	Universal Postal Union	No
19	WHO	World Health Organisation	No
20	WIPO	World Intellectual Property Organisation	No
21	WMO	World Meteorological Organisation	No

22	World Bank	World Bank	Yes
23	UNAIDS	Joint United Nations Programme on HIV/AIDS	No
24	UNHCR	United Nations High Commissioner for Refugees	Yes
25	UNIDIR	United Nations Institute for Disarmament Research	No
26	UNITAR	United Nations Institute for Training and Research	Yes
27	UNOPS	United Nations Office for Project Services	No
28	UNRWA	United Nations Relief and Works Agency for Palestine Refugees in the Near East	No
29	UNSSC	United Nations System Staff College	No
30	UNU	United Nations University	No
31	UN WOMEN	UN Women	No
32	CTBTO	Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation	No
33	IAEA	International Atomic Energy Agency	No
34	ICC	International Criminal Court	No
35	IOM	International Organisation for Migration	No
36	OPCW	Organisation for the Prohibition of Chemical Weapons	No
37	UNFCC	United Nations Framework Convention on Climate Change	Yes
38	WTO	World Trade Organisation	No
39	ITC	International Trade Centre	No
40	IIEP	International Institute for Educational Planning	Yes
41	IPCC	Intergovernmental Panel on Climate Change	Yes
42	WASP	World Adaptation Science Programme	Yes
43	Brookings	The Brookings Institution	Yes
44	NORRAG	Network for international policies and cooperation in education and training	Yes
45	RISE	Research on Improving Systems of Education	Yes

46	WEF	World Economic Forum	Yes
47	GPE	Global Partnership for Education	Yes
48	OECD	Organisation for Economic Co-operation and Development	Yes
49	WLL	World's Largest Lesson	Yes
50	GEF	Global Education Futures	Yes

LIST OF PUBLICATIONS REVIEWED IN THE INTEGRATIVE REVIEW PROCESS APPENDIX 2

No.	Organisation	Publication title	Staged review outcome
1	UN	Sustainable Development Goal interactions through a climate lens: a global analysis	Pass
2	UN	Climate Change 2022: Mitigation of Climate Change	Pass*
3	UN	Sustainable development begins with education	Pass
4	UN	UNESCO Roadmap for Implementing the Global Action Programme on Education for Sustainable Development	Pass
5	UNDP	State of Climate Ambition	Fail
6	UNDP	UNDP Annual Report 2022	Fail
7	UNEP	Adaptation Gap Report 2022	Pass
8	UNEP	The Sustainable Development Goals Report 2022	Fail
9	UNEP	UNEP Annual Report 2022	Fail
10	UNICEF	The coldest year of the rest of their lives	Pass
11	UNICEF	The Climate Crisis is a Child Rights Crisis	Pass
12	UNICEF	The State of the World's Children 2023	Fail
13	UNICEF	UNICEF Annual Report 2021	Fail
14	UNICEF	Climate and Environment Readiness Assessment	Pass
15	WFP	WFP Annual Review 2021	Fail
16	UNESCO	Global Education Monitoring Report 2021/2: Non-state actors in education	Pass
17	UNESCO	Global Education Monitoring Report 2016: Education for people and planet	Pass
18	UNESCO	Climate change education for sustainable development: the UNESCO climate change initiative	Pass

19	World Bank	World Development Report 2022: Finance for an Equitable Recovery	Fail
20	World Bank	World Development Report 2018: Learning to Realize Education's Promise	Fail
21	World Bank	Human Capital and Climate Change	Pass
22	UNFCC	UNFFC Annual Report 2021	Fail
23	UNFCC	The Glasgow 10-year Work Programme on Action for Climate Empowerment from COP26	Pass
24	IIEP	Structure of the Education System	Fail
25	IPCC	AR6 Synthesis Report: Climate Change 2023	Pass
26	WASP	Adaptation Gap Report 2022	Pass**
27	Brookings	A new green learning agenda: Approaches to quality education for climate action	Pass
28	Brookings	Unleashing the creativity of teachers and students to combat climate change: An opportunity for global leadership	Pass
29	NORRAG	NSI 07: Education in Times of Climate Change	Pass
30	NORRAG	Systems Thinking in International Education and Development	Fail
31	RISE	Applying Systems Thinking to Education: The RISE Systems Framework	Fail
32	RISE	The learning crisis	Fail
33	RISE	Linking Global Education and the Climate Crisis: An Alternative Approach	Pass
34	WEF	Global Risks Report 2023	Pass
35	GPE	GPE Annual Report 2022	Pass
36	GPE	Toward climate-smart education systems: A 7-dimension framework for action	Pass
37	OECD	Education Policy Outlook	Pass
38	OECD	The Climate Action Monitor	Fail
39	WLL	Transforming Education Survey Report	Pass

40	GEF	Educational Ecosystems for Societal Transformation	Pass

* Included in IPCC AR6 Synthesis Report

** Duplicate with UNEP Adaptation Gap Report 2022