An Oasis for students

Investigating the potential co-benefits of schoolyard redesign for climate adaptation

Alice Aimée Schneider

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LUCSUS
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Supervisor: Sara Ullström, LUCSUS, Lund University

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Abstract

Due to climate change and the urban heat island effect, urban areas face increasing heat stress, a change that has severe consequences on human health. While the need for climate adaptation is pressing, the impact of climate adaptation projects on other sectors also needs to be carefully examined. Much scholar work has focused on how to best align different sectoral goals; however, very little research has investigated the links between climate adaptation and the education sector. This thesis targets this knowledge gap by using the case of an on-going schoolyard transformation project in Geneva, Switzerland. Based on a co-benefit approach to climate policy, two dimensions are investigated: (1) the potential co-benefits that the project can cater to students attending the targeted school, and (2) the factors facilitating or hindering students' participation in the project. For the first question, I carried out a systematic literature review on the impact of heat-reducing features (green, blue and other measures) implemented in the school context. For the second question, I conducted interviews with project leaders and analysed them with regards to seven dimensions of youth participation: purpose, positioning, perspective, power relations, protection, place and process. The review uncovered six domains of potential co-benefits: attitudes towards the schoolyard, physical health, social health, psychological health, cognitive development and academic performance, and environmental orientation. Within these domains, co-benefits are manifold and potentially reinforcing. The literature review did not reveal any potential co-harms. Interview analysis showed that students' involvement in the project was facilitated by the purpose and topic of the project, the position of students as users, the attitude of the school staff and the active engagement of participation experts. Meanwhile, challenges arose in relation to the experts' position, the diversity of the student body and the constrains of the school setting. This thesis provides supporting arguments for future schoolyard transformation projects in order to address urban heat stress while providing a school environment supportive of students' wellbeing. Further research is needed to evaluate the extent to which these co-benefits arise upon completion of the project and the way students' involvement affect these. This thesis also reflects on the limits of co-benefits approaches and the need for investigating the potential negative impacts and trade-offs embedded in climate adaptation projects.

Keywords: urban heat island, education, children, health, schoolyard greening, youth participation

Word count (thesis): 11 995

Résumé

En raison du changement climatique et de l'effet d'îlot de chaleur urbain, les zones urbaines sont confrontées à une augmentation croissante des fortes chaleurs, un changement qui a de graves conséquences sur la santé humaine. Tandis que le besoin d'adaptation climatique est pressant, l'impact des projets d'adaptation climatique sur d'autres secteurs doit également être examiné avec attention. De nombreuses études se concentrent sur la meilleure façon d'harmoniser les différents objectifs sectoriels ; cependant, très peu de recherches ont étudié les liens entre l'adaptation climatique et le secteur de l'éducation. Cette thèse vise à combler cette lacune en s'appuyant sur le cas d'un projet de transformation d'une cour d'école à Genève, en Suisse. Adoptant une approche de la politique climatique fondée sur les co-bénéfices, deux dimensions sont étudiées : (1) les co-bénéfices potentiels que le projet peut offrir aux élèves de l'école concernée, et (2) les facteurs qui facilitent ou limitent la participation des élèves au projet. Pour la première question, une revue systématique de littérature est réalisée concernant l'impact des mesures de réduction de la chaleur (végétation, eau et autres mesures) mises en œuvre dans le contexte scolaire. Pour la deuxième question, des entretiens avec des responsables du projet sont analysés en fonction de sept dimensions de la participation des jeunes : objectif, positionnement, perspective, relations de pouvoir, protection, lieu et processus. La revue de littérature met en évidence six domaines de co-bénéfices potentiels : les attitudes envers la cour d'école, la santé physique, la santé sociale, la santé psychologique, le développement cognitif et les performances scolaires, et l'orientation environnementale. Dans ces domaines, les co-bénéfices sont multiples et se renforcent mutuellement. La littérature ne suggère aucun co-dommage potentiel. L'analyse des entretiens montre que l'implication des élèves dans le projet est facilitée par l'objectif et le thème du projet, la position des élèves en tant qu'utilisateurs, l'attitude du personnel de l'école et l'engagement actif d'experts de la participation. Toutefois, des difficultés existent concernant la position des experts, la diversité du corps étudiant et les contraintes du cadre scolaire. Cette thèse fournit des arguments en faveur de futurs projets de transformation des cours d'école afin de lutter contre la chaleur urbaine tout en offrant un environnement scolaire favorable au bien-être des élèves. D'avantage de recherches sont nécessaires pour évaluer dans quelle mesure ces co-bénéfices se manifestent suite à la réalisation du projet et quelles interactions existent entre participation des élèves et co-bénéfices. Cette thèse propose également une réflexion sur les limites des approches centrées sur les co-bénéfices et sur la nécessité d'étudier les impacts négatifs et les compromis potentiels liés aux projets d'adaptation climatique.

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1 Introduction

In cities of the Global North, increased heat stress has been highlighted as one of the most important risk resulting from climate change (Wamsler, 2014). This is in part due to the interaction of climate change with the urban heat island (UHI) effect, a phenomenon by which higher temperatures are observed in cities compared to their surroundings due to the materials of the urban fabric and anthropogenic heat production (Mohajerani et al., 2017). The interaction of climate change and UHI leads to more frequent and more intense extreme heat events (Harlan & Ruddell, 2011). In turn, these have significant negative social, environmental and economic impacts (Huang et al., 2019). Impacts on human health are especially concerning, in particular for vulnerable populations, such as the elderly, children and chronically ill (Endlicher et al., 2008; Heaviside et al., 2017; Loughnan et al., 2012).

Although tackling the source of the problem through climate mitigation is crucial, climate adaptation also needs to be fostered to address the current and future effects of climate change (IPCC, 2014a). Research has pointed out the importance of mainstreaming climate adaptation into other policy sectors (Wamsler et al., 2014) and considering synergies and trade-offs between social and environmental goals (Khan et al., 2020). A careful consideration of these elements can help mutualize various policy goals in order to develop climate adaptation pathways which can deliver co-benefits to society (Newell et al., 2018).

Additionally, the outcomes of climate adaptation projects may also very much depend on the governance structure supporting them. According to the Intergovernmental Panel on Climate Change (IPCC), engaging relevant stakeholders in urban planning through carefully designed decision-making processes is crucial for the successful development of climate-adapted cities (Revi et al., 2014). Many scholars advocate for participatory processes in urban planning as a way to achieve more effective and/or just policy outcomes (Amado et al., 2009; Chu et al., 2016; Ma, 2017; Maiello et al., 2013; Shi et al., 2016). Therefore, it is important to consider what are the current barriers and opportunities for fostering participation within climate adaptation projects.

1.1 Scope of this study

This thesis explores the issues of cross-sectoral impacts and participation within climate adaptation policy using the case study of the *Cool City* pilot project, an on-going schoolyard transformation project in the Sécheron middle school in Geneva, Switzerland. While redesigning asphalt schoolyards can contribute to reducing the UHI effect (Antoniadis et al., 2018; *Les cours d'écoles 'Oasis'*, 2019; Tsirogiannis et al., 2015), there has been no research on the potential synergies of such initiatives with educational goals. Although the main objective of the project is to reduce the urban heat island effect on the site, considering its impact on students is crucial, as they are both the main users of the schoolyard and the target of educational policies.

Indeed, the school physical environment can significantly affect educational outcomes (Lackney, 1994). In this regard, Titman (1994) notes that schoolyards have a 'hidden curriculum', in so that they carry meanings and influence children's attitudes and behaviours. Carefully planned spaces can contribute to students' wellbeing and academic success (Mazalto, 2017). Therefore, it appears that the transformation of the Sécheron schoolyard can impact many aspects of students' life. Uncovering the co-benefits and co-harms of the project is useful for the development of future projects which could combine environmental and educational goals. In particular, co-benefits could become a useful leverage point for promoting the development of climate adapted schoolyards in the future.

Furthermore, students' participation in the project also warrants attention, as traditional decision-making process in urban planning tend to exclude youth (Frank, 2006). This is particularly relevant as youth participation has significant potential to tackle sustainability issues (Riemer et al., 2014). This thesis is rooted in the idea that students' participation in the project can be beneficial and thus should be promoted in future projects. The theoretical basis for this argument is developed in Section 3.2.1. However, the extent to which students participate in the project may be limited by contextual factors. Additionally, even when students are involved, the extent to which their contribution affect decision-making process may be limited (Cahill & Dadvand, 2018; Hart, 1992). Therefore, it is important to consider which factors facilitate or constrain students' participation and meaningful contribution in the project, in order to address barriers and opportunities to youth participation.

1.2 Aim and research questions

The aim of this thesis is to provide support for the development of climate adaptation projects in the school context. In order to do so, I investigate the potential benefits that the Cool City project can bring to the students of the Sécheron middle school and how students' involvement in such projects can be facilitated. The research questions I address are as follow:

1. What are the potential co-benefits and co-harms of heat reducing measures when implemented in a school context with regard to students' academic performance, physical and mental wellbeing?

2. How is the participatory process within the Cool City project designed and which factors facilitate or hinder students' participation in the project?

1.3 Contribution to sustainability science

Research on the interlinkages between urban climate adaptation and education is still sparse. While studies on co-benefits and co-harms of climate adaptation have addressed impacts on many sectors (de Murieta, 2020), there is no assessment in regard to the school context to the best of my knowledge. Meanwhile, research and initiatives in the field of education regarding sustainability issues has mainly focused on developing programs and teaching materials (Hopkins & McKeown, 2002; Jucker, 2011). There is growing recognition that curriculum should not be the only focus point and that schools themselves should become models of sustainability with regards to their physical environment and governance system (Anderson, 2012; Henderson et al., 2005). More research on the role of schools in outward community involvement for addressing climate issues is also warranted (Jucker, 2011).

Therefore, this thesis contributes to engaging in this knowledge gap. As the integration of environmental and social goals can help address sustainability challenges and avoid negative consequences of unidimensional policy (Khan et al., 2020), investigating how environmental and educational policies can benefit from concerted action is highly relevant. Such research could help uncover potential synergies between these two policy sectors.

2 Background

This section introduces the context of my research. I first present adaptation measures to urban heat stress in a climate change context, both generally and in the Swiss context. Then, I introduce the Cool City project, the case study that this thesis focuses on.

2.1 Climate adaptation measures in regard to urban heat stress

Research suggests a variety of measures for reducing heat stress in cities. First, increasing the vegetative cover in the urban fabric, for example with trees or green roofs, can provide a significant cooling effect (Akbari et al., 2016; Revi et al., 2014). Blue infrastructure can also help refresh cities (Gunawardena et al., 2017). Furthermore, switching from low-albedo material such as asphalt to alternative material in the development of the urban fabric can also reduce the UHI (Mohajerani et al., 2017).

As heatwaves are classified as one of the biggest threats for the country (Hohl et al., 2015), the Swiss Federal Office for the Environment (FOEN) recommends similar solutions for developing climate-proof cities. In the report "*When the city overheats – Basis for climate-adapted urban development*", the FOEN (2018) advocates for a series of measures which could successfully reduce heat stress (Figure 1). These measures fall into four categories: green measures (M1), blue measures (M2), buildings-related measures (M3) and other measures (M4) (FOEN, 2018). The latter includes the provision of shade infrastructure or the use of reflective material in open spaces.

The FOEN report constitutes the reference document for the development of the *Cool-City project* (DT, 2019). Although the project aims at implementing measures from all four categories, buildings-related measures (M3) were originally discarded in the specific pilot project considered in this thesis due to financial constraints. Later, as the project was able to secure a larger budget, the possibility of adapting the buildings (such as painting the walls in a light colour) was restored. However, for the scope of this thesis, which focuses specifically on schoolyard design, only green, blue and other measures (M1, M2 & M4) are considered.

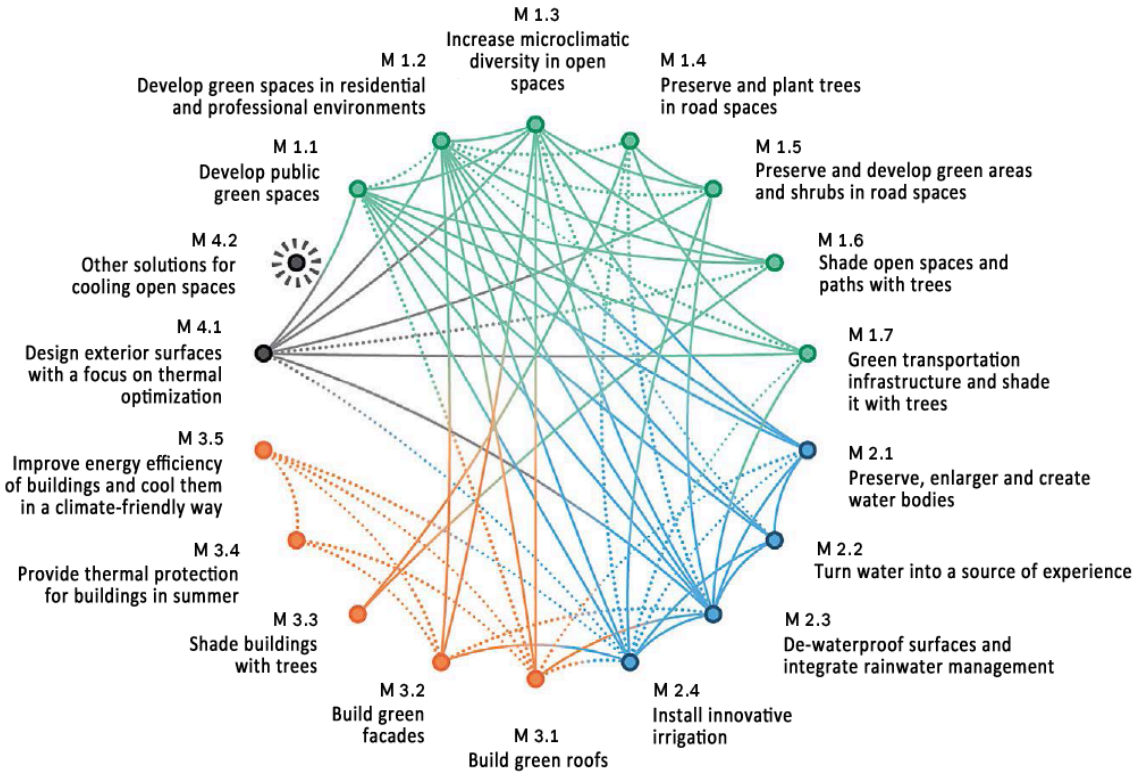

Figure 1. Heat-reducing measures recommended by the Swiss Federal Office for the Environment for the urban context (translated from French). Four categories are identified: green (M1), blue (M2), buildings-related (M3), and other (M4) measures. Potential synergies between these measures are indicated. (FOEN, 2018, p. 40)

2.2 Case study: the Cool City project at Sécheron middle school

This thesis uses the *Cool City Project*, led by the Canton[1] of Geneva, as a case study to understand the co-benefits of heat reducing measures in the school context. The project aims at assessing the current urban microclimate and evaluating the potential and applicability of different types of measures to reduce the UHI effect on the canton's territory (DT, 2019; NCCS, 2019a). The final goal is to develop guidelines and tools to promote the inclusion of urban heat concerns in all sectors and levels of urban planning. Additionally, several pilot projects are conducted in order to test measures and provide tangible examples of what could be done in terms of urban cool spots, both to officials working on the urban space and the larger public.

[1] In Switzerland, a canton is an administrative subdivision under the federal system. Cantons are member states of the Swiss Confederation and are sovereign to the extent that their sovereignty is not limited by federal law. Each canton has its own constitution, legislative and executive bodies as well as administration which fully respects the federal legal bases. The cantons are in charge of their own education system.

The specific pilot project that this thesis investigates involves the transformation of a public middle school yard. Public middle and high schools constitute practical sites to develop such projects, since the land and buildings usually belong to the Canton[2]. As many schoolyards in the Canton are made out of concrete, there is significant potential for reducing the heat island effect by redesigning them in a climate-adapted fashion.

The Sécheron middle school was chosen as the site for this pilot project. Microclimate analysis revealed that the school was located within a heat island, highlighting the potential of transforming the current schoolyard, mostly covered with asphalt (Figure 2). Moreover, the school board had been requesting renovation for several years, a request which could not be fulfilled due to financial constraints. The school staff also expressed great enthusiasm for the project and its link to sustainability. Although originally focused on climate adaptation, the project also caught the attention of additional public actors for its potential in terms of public space planning[3] as it is located within a dense neighbourhood with multiple public services and could benefit to a large group of actors (Figure 3).

Figure 2. Photos of the school grounds of the Sécheron middle school. The current design contributes to the UHI effect due to its impermeable and low-albedo surfaces and lack of vegetation. Copyright P. Moulet. (*Infrastructures du CO Sécheron,* n.d.).

[2] In Switzerland, the public education system is of responsibility of the Canton. In Geneva, the Canton owns and manages public schools from middle school and above, while primary schools are under the responsibility of municipalities.

[3] In Switzerland, public school grounds can be freely used by residents outside of school hours. For this reason, the CEVA Interfaces Unit, specialized in the design and management of public spaces, joined the project. This unit was originally created to design and manage public spaces along the new CEVA (Cornavin – Eaux-Vives – Annemasse) trainline but has expended to include additional projects related to sustainable transport and public spaces. Their collaboration with the Cool City project allowed the project to become bigger, in terms of personnel and financial resources.

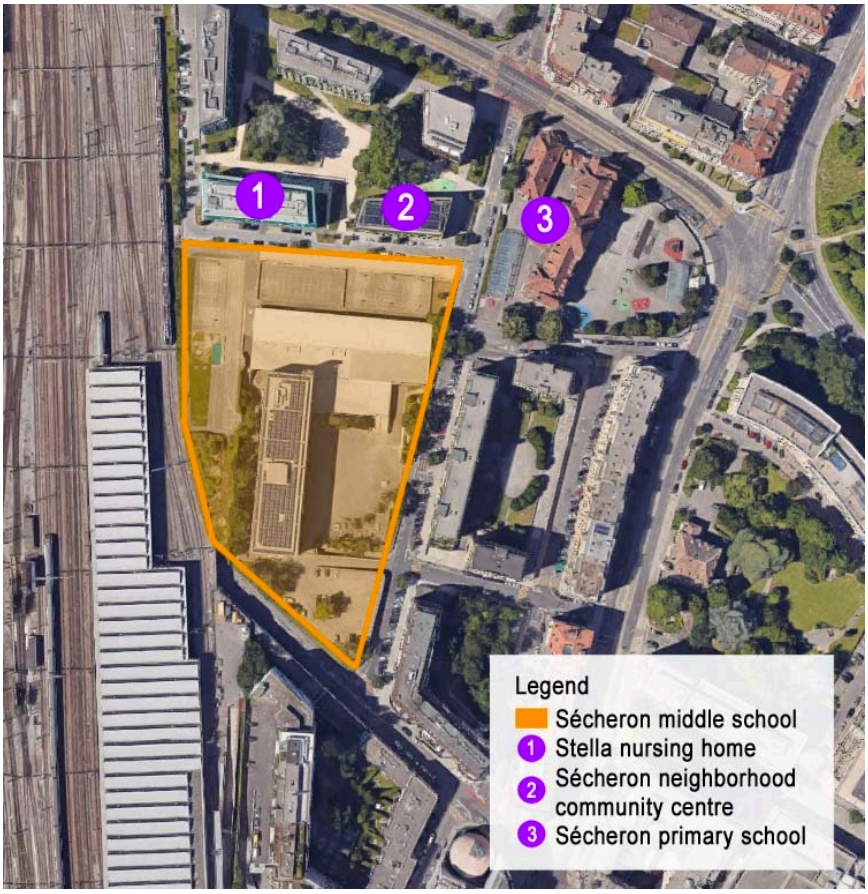

Figure 3. Aerial view of Sécheron middle school and surrounding public services. The schoolyard as a public space has potential to deliver services to a wide range of local actors. (Own illustration. Aerial imagery: Google Maps, 2020)

This pilot project brings together a variety of actors from public offices within the Department of Territory (DT) and the Department of Public Education (DIP) of the Canton of Geneva, as well as external mandated companies. A comprehensive view of all actors involved in the project is given in Appendix I. The project, spanning over several years, was launched in January 2020 and is to be completed by 2024. A participatory process including actors from the school and neighbourhood was organized by urbz, a collective specialized in participatory urban design mandated by the DT Consultation Unit for that purpose, and was scheduled throughout spring 2020 (Figure 4). However, due to the outbreak of COVID-19 and associated sanitary measures, the participatory process could not be conducted as planned. However, as collaboration between various actors is an important component of the project, the process is not cancelled, rather delayed until the situation allows it again.

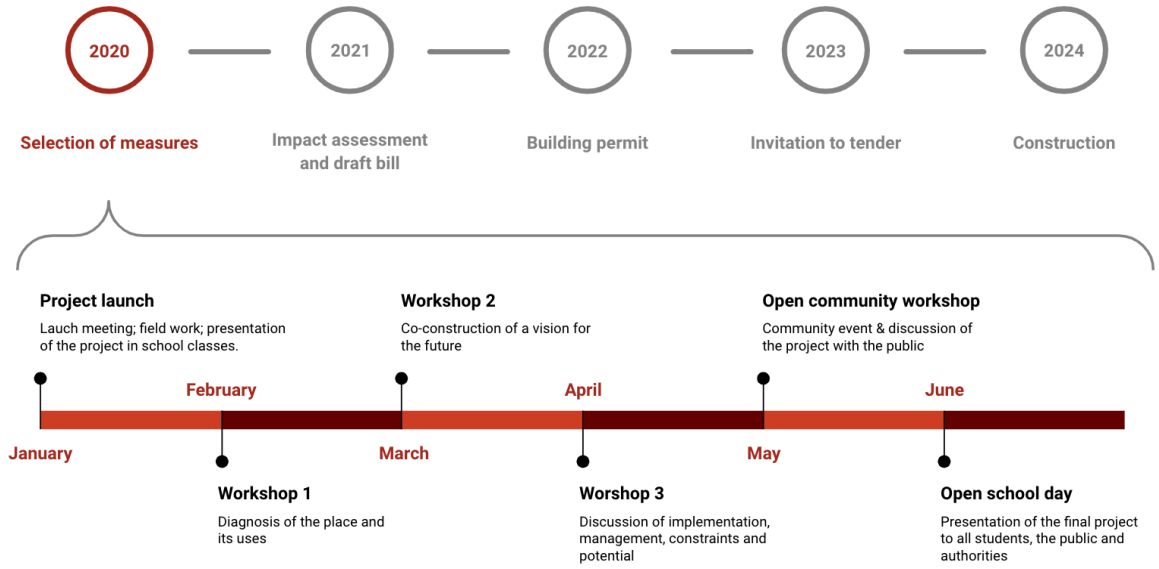

Figure 4. Timeline of the Cool City pilot project in Sécheron middle school and original schedule of the participatory process. Due to the COVID-19 outbreak and associated sanitary measures, only the first workshop could be conducted. Activities planned from March onwards were suspended. (Own illustration, based on Département du Territoire, Service Concertation & Communication, ICEVA, EDMS & urbz, personal communication, January 24, 2020).

3 Theoretical framework

This section provides an overview of the theoretical approach adopted in this thesis. I introduce the concept of co-benefits and its relevance to the case study. After defining youth participation, I provide arguments for its implementation, in particular in regard to schoolyard design, and describe the model used for the analysis of the participatory process.

3.1 Co-benefits approaches to climate policy

While the need for mitigation and adaptation strategies has been recognized, increased attention has been given to the synergies between climate action and other environmental, social and economic goals. The IPCC emphasizes the importance of considering *co-benefits* (also referred to as *ancillary benefits*), defined as "the positive effects that a policy or measure aimed at one objective might have on other objectives" (2014b, p. 1762). Although most policies focus on a single outcome, research has shown that climate policies can have "intended or unintended co-benefits or co-harms across multiple sectors, scales and timeframes, which are often substantial but overlooked" (Spencer et al., 2017, p. 648).

In regard to climate adaptation, research reveals a wide range of potential economic, environmental and social co-benefits (de Murieta, 2020; Spencer et al., 2017), although most literature focuses on the linkages between adaptation measures and human health (Cheng & Berry, 2013; de Murieta, 2020). Measures targeting urban heat stress have the potential to deliver many health co-benefits, although more contextual research is needed to evaluate these benefits in particular cases such as the Cool City project (Harlan & Ruddell, 2011).

While these co-benefits may be "happy accidents", which concurrently arise without being explicitly planned for, a deeper understanding of the synergies and trade-offs between different social and environmental goals can help policy-makers optimize co-benefits when planning for climate adaptation (Newell et al., 2018). Developing strategies that explicitly include co-benefits has the potential to create "win-win" scenarios and foster more integrated planning (Newell et al., 2018). The explicit consideration of co-benefits can also prove useful for climate policy advocacy (Mayrhofer & Gupta, 2016). As co-benefits approaches encompass positive outcomes on different geographic and temporal scale, they can successfully create incentives for individuals and institutions to engage in climate mitigation and adaptation (Spencer et al., 2017). Furthermore, co-benefits can increase the

legitimacy of climate initiatives by providing a broader range of social, economic and environmental improvements (de Murieta, 2020).

While the approach emphasizes the possibility of multiple benefits spanning over different sectors, it can also shed light onto the potential co-harms of specific policies (Spencer et al., 2017). Co-harms can arise when a policy goes against other policy goals, for instance with the use of air-conditioning as an adaptation measure (Cheng & Berry, 2013). Research on environmental justice has also pointed out the potential negative impacts of climate adaptation policies in terms of justice and equity, although the term 'co-harms' isn't used in this literature (Anguelovski et al., 2016, 2019; Checker, 2011; Shi et al., 2016; Shokry et al., 2018). Thus, the distribution of co-benefits and co-harms has to be considered carefully (de Murieta, 2020).

The co-benefits approach presented here can provide a fruitful entry point for considering the impacts of the Cool City project. This approach suggests that the planned adaptation measures could yield co-benefits; however, it remains undetermined what co-benefits and/or co-harms would be specifically catered to the students. If further projects are to be implemented in other schools, providing incentives for schools to adopt adaptation measures in their schoolyard is crucial. Thus, uncovering the co-benefits of adapted schoolyards could promote cross-sectoral cooperation and integrated planning that targets both climate and educational goals.

3.2 Theoretical insights on youth participation

As stated in the introduction, a growing body of research advocates for participatory governance systems in urban planning and climate adaptation strategies (Amado et al., 2009; Revi et al., 2014). Scholars have also pointed out the importance of integrating marginalized and/or vulnerable groups (Polack, 2008). In this regard, there is growing recognition that decision-making processes tend to exclude young people (Frank, 2006; Perri, 2007). Many initiatives have attempted to rectify this inequality by involving this group in urban planning to various degrees and with different objectives (Alparone & Rissotto, 2001; Derr et al., 2013; Francis & Lorenzo, 2002).

Youth participation is also increasingly implemented within the education sector. In the field of Education for Sustainable Development in particular, democratic and collaborative skills are emphasized as a key component of a responsible education for the future (Hopkins & McKeown, 2002;

Reid & Nikel, 2008). The Francophone Swiss Study Plan (PER)[4], which guides educational activities in Geneva, also advocates for participation in class activities and through community projects to develop children's skills for citizenship (CIIP, n.d.).

This thesis borrows Wake's definition of youth participation as young people's "active involvement in a process of decision-making where the fundamental requirement is for power sharing to occur, leading to opportunities for transformational learning" (2015, p. 860). This definition is based on Reid and Nikel's conceptualization of participation in the educational context (2008). By emphasizing power sharing, this definition rejects tokenistic modes of participation in which children do not actively influence the process (Checkoway, 2011; Hart, 1992).

3.2.1 Benefits of youth participation

Different rationales exist for promoting youth participation (Head, 2011) A first argument is that young people have the *right* to be involved (Head, 2011). This rationale has been crystalized in the Convention of the Rights of the Child of the UN, which is often used to advocate for the inclusion of children and teenagers in urban planning (Checkoway, 2011; Frank, 2006). The second rationale is that youth participation generates more *efficient* outcomes (Head, 2011). In this view, the services provided to young people, for instance regarding education, can be improved if they are planned in collaboration with the targeted audience (Head, 2011). Finally, a third argument arises from the observation that participation can provide a range of *benefits*, both for the young people involved and for the surrounding community (Head, 2011).

Regarding this last point, participation can have many positive effects on youth participants. It creates opportunities for young people to acquire new knowledge and develop new skills (Checkoway, 2011; Frank, 2006; Head, 2011). It also encourage self-determination of political beliefs, thus preparing young people to become engaged citizens (Derr & Rigolon, 2016; Hart et al., 1997; Hart, 1992; Wong et al., 2010). Through engaging with other actors, young people also develop cooperation skills and a sense of responsibility and autonomy (Checkoway et al., 1995; Hart, 1992; Hart et al., 1997).

[4] The Francophone Swiss Study Plan (PER) describes the educational objectives of compulsory public education, both in terms of knowledge acquisition in various disciplines and transversal skills which should be developed through all school activities. Since 2013 it is used by all French-speaking Cantons in an effort to harmonize education across Cantons.

Participation also enhances the participants' feeling of ownership of the project (Sabo, 2001), help them build self-confidence and enhance their social connectedness (Checkoway, 2011; Derr & Rigolon, 2016; Head, 2011).

In the context of education, involving students in decision-making about the school affairs is beneficial for developing skills, higher self-esteem, confidence, sense of agency and efficacy (Derr & Rigolon, 2016; Yamashita et al., 2010). Student participation also proved beneficial for a school's positive atmosphere and trust building (Yamashita et al., 2010). Additionally, participation in concrete projects which impact their community is essential for an education to democratic citizenship (Dyment, 2008; Mannion, 2003). Studies evaluating participatory schoolyard (re)design projects highlight the benefits of involving students in all phases of the project (Derr & Rigolon, 2016; Dyment, 2008; Jansson et al., 2018; Mannion, 2003; Wake, 2015). Not only were students more positive toward changes they had taken part in (Jansson et al., 2018), they also felt a strong sense of empowerment and ownership of the project (Derr & Rigolon, 2016; Titman, 1994; Wake, 2015).

Despite these benefits, barriers to youth participation in community projects remain (Frank, 2006). Cultural understanding of young people as "adults-in-becoming" often implies that their capabilities are not fully recognized (Frank, 2006; Hart, 1992; Lekies et al., 2009). This can limit the extent to which adults are willing to share power with young people (Checkoway, 2011). In this context, young people themselves might not feel confident in their ability to endorse responsibilities (Checkoway, 2011; Lekies et al., 2009). Research emphasizes the role of adults for creating opportunities for meaningful participation (Breitbart & Kepes, 2007; Checkoway, 2011; O'Donoghue et al., 2002).

3.2.2 The P7 model of youth participation

As participation has been increasingly implemented in various contexts, many scholars have attempted to conceptualize youth participation in ways that could both inform practice and build theory. Hart's ladder of participation (1992) is the first proposed model to categorize children and teenagers involvement in community project. While it set the foundations for many scholars to develop subsequent models (see Cahill & Dadvand, 2018 for a review), many debates remain. Can participation types be ranked hierarchically or should different forms of participation be viewed as distinct yet equal types (Hart, 2008; Treseder et al., 1997)? When such a ranking is supported, the question of whether youth independence or shared control with adults is the highest form of participation is debated (Wong et al., 2010). The different existing models also hold different assumptions about the final purpose of participation, whether it is youth empowerment, co-learning, education to citizenship, etc.

Building on these debates, Cahill and Dadvand propose the P7 model as a "thinking tool for visioning, planning, enacting and evaluating youth participation" (2018, p. 248). Their comprehensive model builds on a broad theoretical background (feminism, post-structuralism, critical theory, youth and citizenship studies). Their approach is particularly attentive to contextual factors such as culture, the nature of the project, or the age and capabilities of young people, as they argue that there is no one-size-fits-all for participation. It also recognizes that youth being involved does not necessarily guarantee that power will be shared between adults and young people. The model brings the researchers attention to seven domains which crucially affect opportunities for participation: purpose, positioning, perspective, power relations, protection, place and process. Figure 5 illustrates the model as an assemblage, highlighting the interactions between these domains.

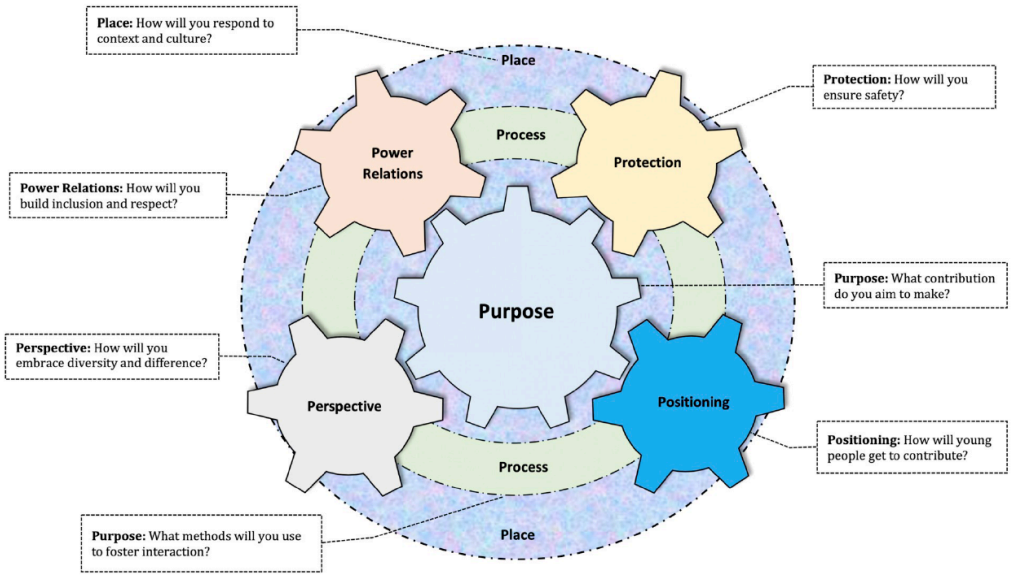

Figure 5. The P7 model of youth participation. Opportunities for youth participation and power sharing is visualised through the assemblage of seven domains, the seven "P"s: Purpose, Positioning, Perspective, Power relations, Protection, Place, and Process. (Cahill & Dadvand, 2018, p. 248)

Using guiding questions suggested by the authors for each domain, I developed an analytical framework to study the participatory process of the Cool City pilot project in Sécheron middle school, with a focus on students as the targeted youth group (Table 1). This framework allowed to identify within each domain what were the contextual elements which facilitated or hindering students' involvement and their meaningful participation through shared power with adults over the decision-making process.

Table 1. Framework for the analysis of the participatory process in the Cool City pilot project in Sécheron middle school. The seven domains refer to those of the P7 model (Cahill & Dadvand, 2018). The analytical questions were developed by adapting the guiding questions proposed by Cahill and Dadvand (2018) to my case study.

Domain	Analytical questions
Purpose	What are the aims of the project? To what extent are students involved in shaping or evolving the project objectives?
Positioning	How is youth perceived by the project leaders, and how does this impact their possibilities for participation? How are the students positioned within the project?
Perspectives	How are students invited or selected to participate? Whose perspectives and voices are included, excluded or privileged in the project? Who remains marginalized or is rendered 'voiceless' in the process?
Power relations	What roles and responsibilities do students and adults adopt within the project? How are relationships managed to ensure equity and respect is enacted between all parties?
Protection	Does participation create any personal, social or political risk for the students involved? In that case, what practices are implemented to protect the students from these risks?
Place	What are the social, physical and virtual spaces in which participation takes place? What mediates access to these spaces? How does the spatial context affect what is possible or desirable in relation to participation?
Process	What methods are used throughout the participatory process? To what extent do these enable participatory exchange, and critical and creative though? To what extent do these foster practices of inclusion, respect and support for others?

4 Research design and methodology

This thesis uses a single case study as the research design, as it particularly relevant for descriptive and explanatory research questions, and allows for study of phenomena within their context (Yin, 2009). The Cool City project is a relevant case to study the interconnections between climate adaptation and education as it bridges these two sectors of interest, in regard to its goals, the actors involved and its spatial context. Distinct methodologies grounded in the case study were developed to answer the two research questions. RQ1 is answered through a systematic literature review. Contextual elements from the case study are used to build search queries and selection criteria. RQ2 is addressed with qualitative interview data, interpreted through the analytical framework presented previously (Table 1).

Access to the field was obtained by contacting the project coordinator in the early stages of this research. Informal discussions with this key informant provided me with an understanding of the project. Two presentation documents describing the project were also obtained. As these documents gave a clear overview of the participatory process and activities, they were used as a basis for understanding the process before conducting interviews. Contacts with interviews respondents were also obtained through the project coordinator.

4.1 Methods for answering RQ1

In order to reveal the potential co-benefits of heat-reducing measures in the school context, a systematic literature review was conducted (Gough et al., 2017) using the electronic databases Scopus and Web of Science. Peer-reviewed literature from 1960 to February 2020 was retrieved, which addresses the impact of heat-reducing measures from the FOEN report (2018) in the school context. The search terms used for the three types of measures are indicated in Table 2; these were combined with keywords related to school context to find relevant literature (see Appendix II for search queries).

Table 2. Types of heat-reducing measures based on the FOEN report, their potential applications to a schoolyard renovation projects, and keywords used in search queries for the systematic literature review.

N°	Type of measure	Examples related to my case	Keywords used in search
M1	Green measures	Planting trees, grass and other forms of vegetation in the schoolyard	Tree, green, vegetation
M2	Blue measures	Building fountains or creating ponds in the schoolyard	Blue, water, pond, wetland, fountain, river, lake
M4	Other measures	Changing material composition of the yard, building covers to provide shade	Albedo, reflective, asphalt, shade

The searches returned a total of 235 results, excluding duplicates. A systematic selection was conducted to determine which publications should be included in the review (Figure 6). Due to the large number of publications found, a first selection was performed by reading titles using the following criteria:

- The broad topic of the publication is related to schoolyard design. Whenever uncertainty remained, the article was included in the next round of screening.
- The article is published in English and full text is available.

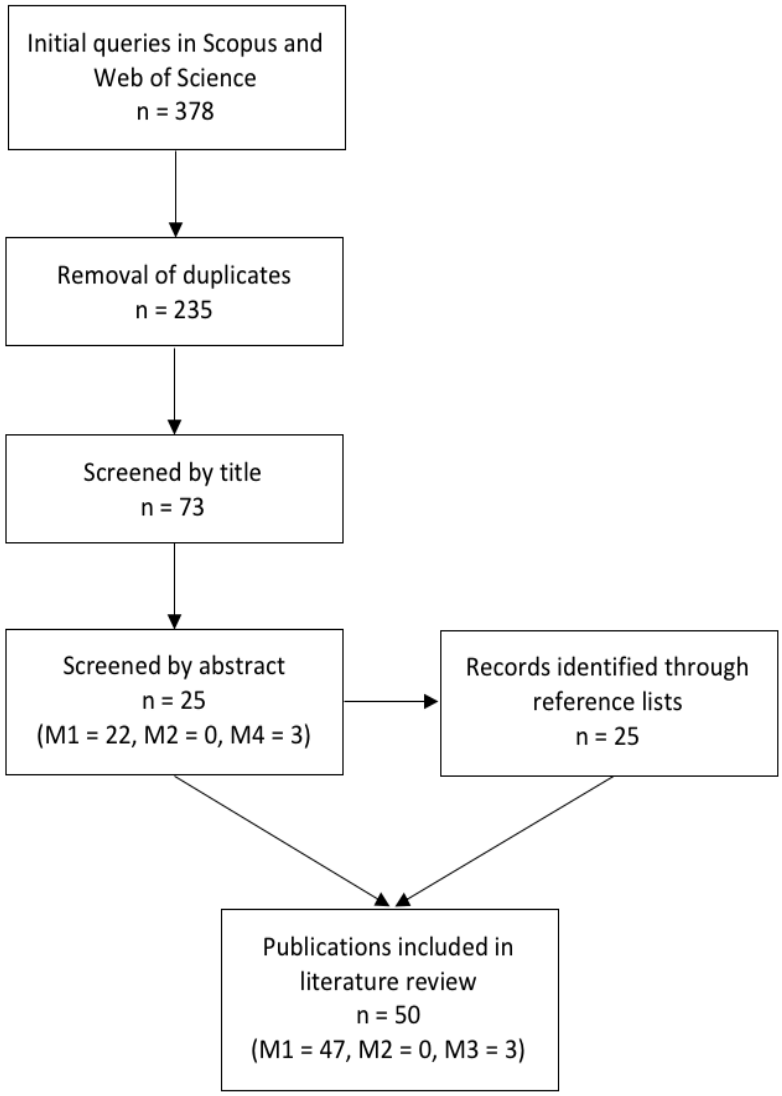

Figure 6. Diagram of the procedure followed for the systematic literature review. The selection criteria focused on literature about the impacts of heat-reducing measures (M1 = green measures, M2 = blue measures, M4 = other measures) on students. (Own illustration).

This first cursory selection allowed to efficiently remove many irrelevant or inaccessible articles. A second round of screening was then based on the abstracts and used the following selection criteria:

- The publication addresses the implementation of at least one of the measures identified above (M1, M2 or M4) in the school context, i.e. the measure is implemented directly on the school grounds or in the near vicinity with a direct link to the school.
- The article addresses the (positive or negative) impact of said measure on students. Articles discussing technical design questions or implementation challenges were not included.
- The article assesses the impact on children of school age (4 to 18 years old)[5]. This age range corresponds to that of the compulsory schooling system in Geneva from primary to high school[6].

For this selection, I included any intervention or existing feature corresponding to measures indicated in the FOEN report (Figure 1), even if it was not implemented with the purpose of climate adaptation and/or heat stress reduction. Indeed, as climate adaptation projects in schools are relatively scarce, limiting my selection to those would not have yielded enough results to allow for a comprehensive appreciation of the co-benefits/co-harms of these measures. In many cases, the publications evaluate the effect of schoolyard renovations, which include, but are not limited to, installations which fit as heat-reducing measures (such as trees or shade sails). In order to assess the impact of heat-reducing measures specifically, such articles were excluded unless (a) most of the transformed elements could count as heat-reducing measures, or (b) the effect of different features were assessed independently.

Additionally, many articles addressed the impacts of activities that could take place in green schoolyards, such as gardening and outdoor classes. These articles were excluded as the observed impacts may be more due to the activity than to the physical environment in which they take place. Studies evaluating the effects of physical features and activities independently were included in the review.

[5] Although impacts may vary depending on the age of the children, literature specifically addressing the case of middle school students was not sufficient to obtain relevant results. Therefore, it seems useful to extend the search to a broader age range.

[6] While compulsory education ends at 15 years in other Cantons, Geneva is the only Canton to have introduced compulsory education until 18 years old since August 2018 (DIP, n.d.).

A final note about the selection criteria relates to the age range of students. Several publications studied cases in preschool with children from 3 to 6 years old. Although compulsory education starts at the age of 4 in Canton Geneva, these publications were still deemed relevant as they were the only studies targeting this younger age range. If they were to be excluded, no evidence could have been presented for children under 7 years old.

After applying these criteria, 25 publications were deemed relevant (Figure 6). The snowball method was then applied: reference lists of all publications were examined using the same criteria as those described above. In the end, a total of 50 publications were selected to conduct the review. Among these, 45 publications address mostly green measures (M1), none blue measures (M2) and 3 other measures (M4). The lack of research on blue measures can be explained as these features are rather uncommon in schoolyards. A few articles discuss the implementation of natural features in school ground, which include both green and blue measures. However, I classified those as M1 since the focus remained on vegetation.

This prevalence of green measures (M1) can be explained by the growing international movement of schoolyard greening which promotes the transformation of "hard, barren expanses of turf and asphalt into places that include a diversity of natural and built elements" (Dyment & Bell, 2008a, p. 953). Although this movement did not emerge from climate adaptation concerns, many practical interventions correspond to heat-reducing measures and thus are highly relevant to my question. The publications which did not discuss schoolyard greening projects addressed the presence of vegetation on or around schoolyards or the installation of shade sail structures. Similarly, these studies did not reflect climate adaptation concerns, but still provide useful insight for my research question.

Upon reading, the articles were manually coded to allow for a systematic classification of the observed impacts. In order to do so, I coded the dependent variables assessed in each article. Thus, one or more impact codes were associated to each article (for example: standardized test scores). Then I compiled these codes and grouped them by similarities, revealing 12 dimensions of potential impacts. These dimensions were then grouped into domains, based on which aspect of student's life they affected. Articles were then reviewed again in the light of the categories to highlight any potential connection between the observed co-benefits. A connection was deemed to exist whenever a study found a correlation between two co-benefits or provided strong theoretical support for such a correlation.

4.2 Methods for answering RQ2

In order to investigate how participation was planned in the Cool City pilot project and which factors enabled or constrained participation, qualitative data was collected through semi-structured interviews (Galletta, 2013). As adults play a crucial role in creating the opportunities for youth participation (Checkoway, 2011), project leaders are a relevant group to consider for my research question. Purposive sampling was used to select respondents for the interviews (Robinson, 2014). Four interviews were conducted with key actors involved in the design of the participatory process and/or the coordination of the project[7] (Table 3; see Appendix I for details).

Table 3. Semi-structured interviews conducted with key actors of the Cool City pilot project at Sécheron middle school. The respondents' position in regard to institutions involved in the project is detailed in Appendix I.

Respondent	Interview date	Respondent's position
R1	April 2nd	Coordinator of the Cool City project
R2	April 8th	Project manager Consultation at the Office of Urban Planning
R3	March 31st	Urbz collaborator in charge of the participatory process
R4	March 30th	Head of the Logistics Unit of the Department of Public Education

Although the respondents' involvement in the design of the participatory process varied considerably, the same interview guide was used for all interviews (Appendix III). This allowed to cover similar themes across all respondents (Brinkmann & Kvale, 2018). Second questions were then useful in getting more details from the respondent's position within the project (Brinkmann & Kvale, 2018).

Interviews were conducted through online video calls, a method which can successfully mimic face-to-face interviews (James & Busher, 2012). Before starting the interview, respondents were informed about the purpose of the research and gave their consent for the use of the information gathered as well as the mention of their position within the project. Interviews, which lasted between 30 minutes and 1 hour, were recorded, transcribed manually, and then analysed in the light of guiding questions developed from the P7 model (Table 1). A colour code was used to mark elements related to the seven domains in the interview transcripts. In each domain, particular attention was given to enabling and hindering factors. Quotes provided in this report were translated from French to English by me.

[7] Four additional potential respondents were contacted (the school principal, a teacher, and two members of the CEVA Interfaces Unit) but could not be interviewed due to their busy schedules.

5 Results

This section presents both findings of the literature review and the qualitative interview analysis. Regarding the co-benefits and co-harms of heat reducing measures in the school context (RQ1), I provide an overview of the results (Section 5.1); detailed findings are organized by domain of impact (Sections 5.1.1 to 5.1.6). For the analysis of the participatory process (RQ2), a description of the process is provided (Section 5.2) before I present the factors which facilitate or hinder students' participation in the Cool City project (Section 5.2.1 and 5.2.2).

5.1 RQ1: potential impacts of heat reducing measures on students

The review revealed six domains in which the impact of heat-reducing features is observed (Table 4). The first domain relates to students' use and appreciation of the schoolyard, as well as the type of play it fosters. The second domain addresses the impact of schoolyard design on students' physical health, including their exposure to health risks and their level of physical activity (PA). The third domain, social health, considers how schoolyard features can impact social interactions and inclusion. The fourth domain contains aspects of psychological health, such as students' resilience to stress and the restorative potential of the schoolyard. The fifth domain encompasses elements regarding student's cognitive development and their academic performance. Finally, the sixth dimension consists of the effect of heat-reducing features on students' environmental orientation. Some publications assessed the effect of a specific feature on several domains, and thus were classified in all relevant categories.

Table 4. Domains of observed impacts of heat-reducing measures on students in the literature selected for the review. The number of publications for each sub-dimension is indicated. Publications may be marked in several sub-dimension when appropriate.

N°	Impact domain	Sub-dimensions	Publications
I1	Attitudes toward schoolyard	Students' use	6
		Type of play activities	4
		Students' preferences	5
I2	Physical health	Exposure to health risks	8
		Physical activity (PA)	16
I3	Social health	Peer-to-peer interactions	5
		Social inclusion	4
I4	Psychological heath	Stress level and resilience	6
		Perceived restorativeness	7
I5	Cognition and performance	Cognitive functioning	7
		Academic performance	8
I6	Environmental orientation	Environmental knowledge and attitudes	5

The reviewed publications show that implementing heat-reducing measures (vegetation, water or shade sails) in schoolyards can engender a wide range of benefits for students (Figure 7). While vegetation can deliver all identified co-benefits, water and shade sails were only found to affect two out of the six domains each (Figure 7). Supporting evidence for each co-benefit is presented in the following sections, organized by domain. The review also revealed connections between these co-benefits (Figure 7), suggesting that they can reinforce each other.

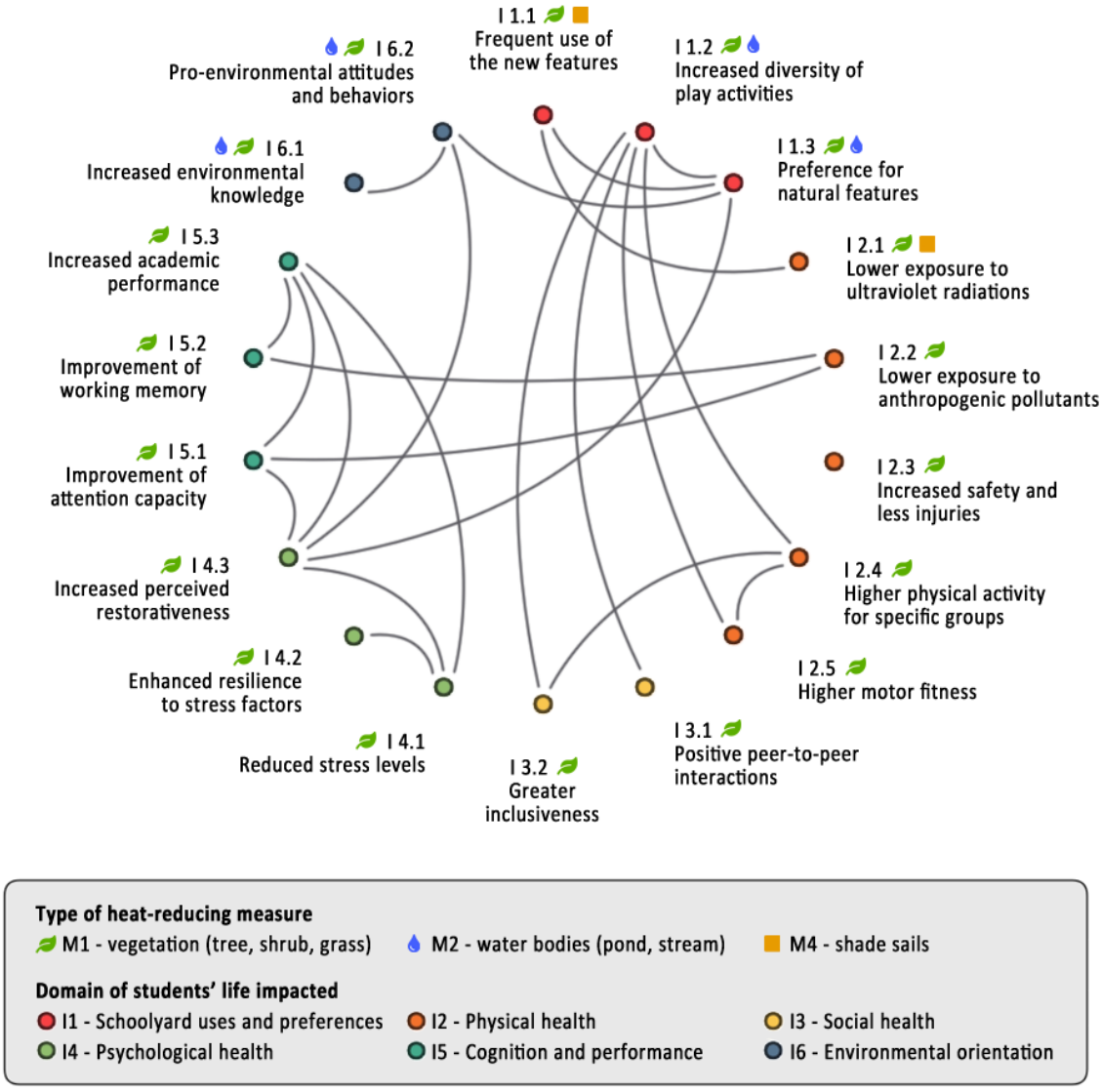

Figure 7. Potential co-benefits for students of each type of heat-reducing features (vegetation, water bodies and shade sails) identified through the literature review, grouped by domain. Connections are indicated when at least one selected publication observed a correlation between two co-benefits or provided strong theoretical support for the existence of such a connection. (Own illustration).

While the selection criteria for the review allowed the inclusion of both positive and negative impacts, the literature found did not present any evidence of co-harms. One article briefly mentioned the importance of avoiding poisonous and allergenic plants in schoolyard design (Kopeva et al., 2017); however, this co-harm can be easily avoided when designing schoolyards. Therefore, my results focus explicitly on the co-benefits of heat-reduction measures. I consider potential reasons for the lack of research on co-harms and potential implications in my discussion (Section 6).

5.1.1 Students' uses and preferences of schoolyard design

Physical features in a schoolyard, among which those with heat-reducing potential, are found to impact students' use of the space (where students play), type of play activities (what students do in those spaces) and preferences (which features students appreciate). Although these findings do not constitute co-benefits per se, they are important to understand the co-benefits presented in the next sections. Moreover, if students do not use or enjoy the heat-reducing measures installed in their schoolyard, co-benefits may not be delivered.

The reviewed publications indicate that green areas (M1) and shade sails (M4) are widely used by students. Several studies found that green areas in schoolyards constitute attractive spaces for primary school students to use during recess (Lucas & Dyment, 2010; Mårtensson et al., 2014). Additionally, the integration of the natural features in the built environment encourages students' use (Mårtensson et al., 2014). Research also revealed a correlation between the amount of vegetation on school grounds and time spent outdoor in preschool (Söderström et al., 2013) and elementary school (Arbogast et al., 2009). Aside from green measures, Dobbinson et al. (2009) found that the shade sails installed in 25 Australian schools were widely used by students. Shade cover for resting features also increased utilization of schoolyards outside school hours by adults and boys in urban schools in Cleveland (Colabianchi et al., 2011).

Heat-reducing measures can also impact the way students play in the schoolyard. Comparative studies have found that greener and more biodiverse schoolyards afford a wider range of play activities (Jansson & Mårtensson, 2012; Samborski, 2010). While most students on asphalt schoolyards engage in ball games, chasing games and sports (Jansson & Mårtensson, 2012), green schoolyards offer more possibilities for functional, constructive and symbolic play (Samborski, 2010; Tranter & Malone, 2004). The study of a forested schoolyard also revealed that the diversity of play activities is also enhanced by the diversity of landscape elements (vegetation and topography) (Fjørtoft & Sageie, 2000).

Regarding students' preferences, research suggest that natural elements are highly valued by students (Stanley, 2011). Green features were predominantly mentioned by a sample of primary school students asked to imagine their ideal schoolyard (Sharma-Brymer & Bland, 2016). A longitudinal study of schoolyard greening projects also found that students' appreciation of their schoolyard increased upon completion of the projects and remained higher than control schools even 2 years later, in particular among younger children and girls (van Dijk-Wesselius et al., 2018). Alternatively, some

studies found that students having access to nature in their schoolyards express a stronger preference for these features than students who do not (Samborski, 2010; Tranter & Malone, 2004).

To summarize, green areas and shade sails are used and appreciated by students. These elements can encourage students to spend more time outdoors during recess, and residents to use the area as a park outside school hours, thus catering co-benefits to a wider audience. Moreover, green spaces can create opportunities for diverse play activities. This is an important finding for explaining some of the co-benefits presented further. Finally, while some studies suggest that children prefer natural settings for their school ground, others show that this preference is more developed among children who have access to a more natural school ground. This second aspect suggest that greener school grounds could play a role in developing a sense of attachment to nature.

5.1.2 Physical health: risk exposure and physical activity

Heat-reducing measures in schoolyards can contribute to reduce exposure to health risks. Additionally, a large number of studies have investigated the potential of green schoolyard to promote students' PA. As risk exposure reduction and sufficient PA are critical for preventing many health risks in the long term, the potential of schoolyard features to impact students' physical health should not be underestimated (Boldemann et al., 2006)

Regarding risk exposure, shade created by trees (M1) or shade sails (M4) can significantly reduce exposure to UVR (Bell & Dyment, 2008; Boldemann et al., 2006, 2011; Vanos et al., 2017). Greenery in the schoolyard can also reduce exposure to anthropogenic pollutants (Kopeva et al., 2017), including pesticides (Bell & Dyment, 2008) and traffic-related air pollution (Dadvand et al., 2015a). Additionally, vegetated schoolyard with softer surfaces can improve students' safety (Bell & Dyment, 2008). In a longitudinal assessment of schoolyard greening projects in Chicago, teachers reported that the new schoolyards were safer and caused less injuries (Bates et al., 2018). Finally, a comparative study found that children attending preschools with more trees, shrubbery and hilly terrain, had leaner bodies and longer night sleep (Söderström et al., 2013).

While the effect on students' PA is one of the most discussed aspect in the literature regarding green schoolyards, the results reveal a contrasted picture. On the one hand, some studies found that green areas and soft surfaces can boost primary school students' level of PA and decrease sedentary behaviour (Bates et al., 2018; Brink et al., 2010; Dyment & Bell, 2007, 2008a; Raney et al., 2019). Two longitudinal studies reported a significant increase in PA after completion of schoolyard greening

projects (Bates et al., 2018; Raney et al., 2019). Two comparative studies of preschools in Sweden found that schoolyards with more vegetation and hilly terrains triggered children' PA (Boldemann et al., 2011; Boldemann et al., 2006). Furthermore, children playing in a forested schoolyard displayed significant increase in motor fitness (Fjørtoft, 2004; Fjørtoft & Sageie, 2000). Finally, a survey-based study of schools across Canada indicates that green schoolyards facilitate the integration of PA into school life (Dyment & Bell, 2007, 2008a).

Additional studies paint a more nuanced picture of the connections between green features and PA by considering gender differences. Findings show that green schoolyards promote PA among girls only (Fjørtoft et al., 2009; Pagels et al., 2014; Raney et al., 2019; van Dijk-Wesselius et al., 2018). While areas for competitive sports and ball games tend to promote boys' PA, many girls engage in PA in greener areas (Pagels et al., 2014). This reflect the different affordances that various areas of a schoolyard provide to children. As green areas offer a wider variety of play activities (see Section 5.1.1), they offer alternatives to more traditional sport equipment which only attracts students interested in competitive games (Samborski, 2010). Due to gendered social roles, these traditional school grounds tend to stimulate boys' PA (Dyment & Bell, 2008b). Additionally, green areas appear to encourage moderate levels of PA, in contrast with sports field for instance which encourage vigorous levels of PA (Dyment et al., 2009; Dyment & Bell, 2008a). As moderate PA can also significantly contribute to children's health, green spaces can improve the health of students who are less interested or unable to take part in competitive sport (Dyment & Bell, 2008a).

Finally, the review also included two comparative studies which found no correlation between the amount of greenery in the schoolyard and the students' levels of PA (Fjørtoft et al., 2009; Mårtensson et al., 2014). These apparently contradicting results may be due to differences in measuring tools. For example, by using average heart rate as a measure of PA, Fjørtoft et al. (2009) only accounted for vigorous PA, thus leaving potential effect of green areas on moderate PA unexplored. Additionally, some authors observed an effect of novelty as students' PA levels increased immediately after the schoolyard is renovated before decreasing again (Raney et al., 2019; van Dijk-Wesselius et al., 2018).

Altogether, these studies indicate that green features (M1) can provide significant co-benefits for students' physical health. By reducing exposure to UVR and anthropogenic pollution while increasing safety, these features can help create a healthy environment for school children. In regard to UVR exposure, shade sails (M4) also provide considerable co-benefits. Green schoolyards have also been found to increase students' PA and motor fitness, although those results are debated. Their potential to offer alternative PA opportunities girls is to be noted.

5.1.3 Social health: peer-to-peer interactions and inclusion

The social dynamics in which students engage during recess are influenced by the context in which they take place, including the physical environment of the schoolyard (Bell & Dyment, 2008). Thus, different physical features may promote different social behaviours. A range of reviewed studies investigated the impact of schoolyard greening (M1) on student's social life. This impact should not be disregarded, as school constitute a crucial place for children's social learning (Bell & Dyment, 2008).

Results suggest that green schoolyards foster positive interactions on the school grounds. A survey of teachers and staff found that interactions among students and between teachers and students had improved and cooperative behaviours were more common after the schoolyard had been greened (Bell & Dyment, 2008; Dyment & Bell, 2008b). Similarly, longitudinal studies observed significant increase in positive interactions and social support and decrease of peer problems such as teasing, bullying, physical and verbal conflicts (Bates et al., 2018; Raney et al., 2019; van Dijk-Wesselius et al., 2018).

Additionally, studies of green schoolyards revealed that they foster inclusion and equality. In the survey conducted by Dyment and Bell (2008b), school staff indicated that their schoolyard was more inclusive regarding gender, class, race and ability after the greening project. This effect can be explained by the diversity of play activity (see Section 5.1.1) and its impact on physical activity (see Section 5.1.2). Indeed, green areas are more inclusive as they allow for more open-ended and flexible activities (Bell & Dyment, 2008; Dyment & Bell, 2008a; Jansson & Mårtensson, 2012). For instance, green spaces can alter traditional hierarchies found in the schoolyards in which boys of high physical ability tend to dominate the space (Bell & Dyment, 2008).

However, results also indicated that these co-benefits depend on contextual factors, and not only on physical features present in the schoolyard. Bell and Dyment (2008) noted the determining role of schoolyard culture (for instance, the rules of play or the role of supervisors), which depends on the school policies and pedagogical views. Furthermore, co-benefits on social health are enhanced when students are involved in the schoolyard greening projects (Dyment & Bell, 2008a), a point which I address with my second research question (Section 5.2). Finally, improved social interactions can extend beyond the school actors when greening projects involve parents and local community members (Bell & Dyment, 2008; Dyment & Bell, 2008b).

Overall, the literature review suggests possible improvements of students' social health through green measures (M1). These co-benefits include more positive peer-to-peer relations, as well as improved

inclusion with regards to gender, class, race, age and ability. These co-benefits may be enhanced or limited by contextual factors, such as school policies and the modalities of the greening process.

5.1.4 Psychological health: stress, resilience and restoration

While creating school environments that are supportive of children's psychological health is crucial (Chawla et al., 2014), studies have investigated the potential of green features (M1) for building resilience to stress factors, as well as for providing students with restorative environment. These studies are grounded in two major theories linking nature and mental health: Stress Recovery Theory (Ulrich et al., 1991) and Attention Restoration Theory (Kaplan et al., 1998; Kaplan, 1995).

In their early literature review on the interlinkages between green schoolyard and health promotion, Bell and Dyment (2008) noted that green features (M1) can improve mental health through stress relief and increased sense of competence. Additional studies have confirmed these findings. Corraliza et al. (2012) found that nature at school acts as a moderator of stress, making children more able to cope with stressful events. In a quasi-experimental study, Kelz et al. (2015) found that students had lower physiological stress levels after their schoolyard was greened. Chawla et al. (2014) also observed that elementary students playing in a forested schoolyard enjoyed a high sense of competence and cooperation, which supported their wellbeing and resilience. Furthermore, there is evidence that the simple view of greenery through classroom windows during break time helps stress recovery (Li & Sullivan, 2016). Only one study did not find a correlation between greenery and self-reported stress level (Akpinar, 2016).

Several studies investigated the correlation between features of the school grounds and students' perceived restorativeness of this space (Akpinar, 2016; Amicone et al., 2018; Bagot et al., 2015; Collado & Corraliza, 2012, 2013; Kelz et al., 2015; Paddle & Gilliland, 2016). Perceived restorativeness refers to a combination of four elements (being away, fascination, extent and compatibility) which help restore an individual's attention capabilities (Amicone et al., 2018). Green features (M1) were found to increase perceived restorativeness in various school contexts (Akpinar, 2016; Amicone et al., 2018; Bagot et al., 2015; Collado & Corraliza, 2012, 2013; Kelz et al., 2015). This effect appeared to be stronger for younger children (Bagot et al., 2015; Collado & Corraliza, 2012). Finally, an investigation of different tree types and seasonal changes revealed that fall foliage colour is as restorative as green foliage, while the presence of evergreen conifers increases the restorative capacity of the schoolyard in winter (Paddle & Gilliland, 2016).

These results indicate that green measures (M1) could enhance students' psychological health as they help stress recovery and attention restoration. These co-benefits seem to appear both from direct contact with nature and viewing nature through windows. Theory indicates that this applies to various natural elements, suggesting that natural blue features (M2), such as streams and ponds, could provide the same co-benefits (Chawla et al., 2014). However, specific studies on this aspect have not been conducted yet.

5.1.5 Cognitive development and academic performance

The school physical environment can also have a significant impact on students' cognitive functions, such as sustained attention and working memory, and their performance in school. As schools continuously try to enhance students' learning and abilities, the impact of the physical environment needs to be considered. This review shows that green features (M1) can support students' cognitive development and improve their academic performance.

Studies have shown that students who have access to vegetation in their schoolyard perform better in sustained and selective attention tests (Amicone et al., 2018; Li & Sullivan, 2016; Mårtensson et al., 2009; van Dijk-Wesselius et al., 2018) , as well as working memory tests (Amicone et al., 2018; Dadvand et al., 2015b). Only one study found no correlation when comparing students' attention tests results before and after schoolyard greening (Kelz et al., 2015). However, van Dijk-Wesselius et al. (2018) note that attentional capacity increased in schools where greening projects had been implemented for a longer period, suggesting that such change may be imperceptible in the short term. Additionally, viewing greenery out of the window of a classroom during break time can also trigger attention restoration (Li & Sullivan, 2016). These co-benefits appear to impact students of all age, as similar results have been found in preschool (Mårtensson et al., 2009), primary school (Amicone et al., 2018; Dadvand et al., 2015b; van Dijk-Wesselius et al., 2018) and high school (Li & Sullivan, 2016).

Research suggests several explanations for the effect of green features on cognitive development. Firstly, natural environments can help recover from mental fatigue and reduce stress levels (see Section 5.1.4), two elements which can impede cognitive functioning (Li & Sullivan, 2016). Secondly, the diversity of play activities that green schoolyards allow is favourable to a healthy cognitive development (Dyment & Bell, 2008a). Thirdly, to the extent that green schoolyards can successfully promote PA, they can also enhance cognitive development, as these two elements are mutually reinforcing (Dyment & Bell, 2008a). Finally, this effect can be partly explained by the detrimental effect of pollution exposure on cognitive development: while students attending greener schools

experienced a faster progress in working memory, this relationship was partly mediated by air pollution levels on the school grounds (Dadvand et al., 2015b).

Regarding academic performance, a series of studies found significant correlations between greenery within and around school grounds and standardized test scores (Hodson & Sander, 2017; Kuo et al., 2018; Kweon et al., 2017; Matsuoka, 2010; Sivarajah et al., 2018; Tallis et al., 2018; Wu et al., 2014). While most studies included measures of greenness which expanded beyond the school grounds, vegetation within the school boundaries still played a significant role (Kuo et al., 2018; Kweon et al., 2017; Matsuoka, 2010). One study revealed that this interaction was stronger for disadvantaged students (lower economics status and/or minority status), suggesting that schoolyard greening could be particularly relevant in disadvantaged neighbourhoods (Kuo et al., 2018). One study also found a significant correlation between green features and graduation rates, plans to attend college and less criminal behaviour occurrences (Matsuoka, 2010).

Regarding the type of features, several studies noted that this relation was valid for tree cover, but not for grass cover (Hodson & Sander, 2017; Kuo et al., 2018; Wu et al., 2014). Additionally, tree species diversity combining conifers and deciduous trees seemed to yield the most benefits (Sivarajah et al., 2018). Relationship between academic performance and water bodies (M2) was found to be non-significant (Hodson & Sander, 2017). Only one study did not find any correlation between greenery and academic performance (Browning et al., 2018), but these findings may be due to different types of vegetation not being distinguished (Kuo et al., 2018). Finally, it is worth noting that all these studies used correlational analyses: although they accounted for cofounding factors (such as gender, race, socio-economic status, school size, student-teacher ratio), causality cannot be asserted. Moreover, the analyses were conducted at the aggregate school level; therefore, associations at the individual level cannot be inferred.

To summarize, findings indicate that green measures (M1) can contribute to students' cognitive development and academic performance. The presence of vegetation can enhance attention capacity and working memory for students of all ages. Research also reveals that green features can boost academic performance, although differences are observed depending on the type of vegetation.

5.1.6 Environmental knowledge and attitudes

Several studies investigated how natural features (M1 & M2) on the school grounds affect students' environmental orientation (attitudes and behaviours). Firstly, results show that adding natural

elements to schoolyards can enhance students' knowledge of the environment (Harvey, 1990; Kopeva et al., 2017). For example, Harvey (1990) found that students attending schools with more vegetation had more extensive botanical knowledge, and this effect was reinforced by the diversity and complexity of the vegetation patterns present.

Secondly, green features can enhance students' connectedness with nature, as well as their environmental awareness and stewardship (Bell & Dyment, 2008). Harvey's study (1990) found a correlation between the amount of vegetation of the school grounds and students' attitudes toward pastoralism (whether one enjoys nature) and human dominance (whether one considers that humans can rightly use technology to dominate nature). These findings were confirmed by a more recent study, which found that students' environmental orientation was correlated with the presence of green features in their schoolyards, even after controlling for potential co-founding factors (Collado & Corraliza, 2012). Finally, Collado and Corraliza (2012, 2013) observed a link between perceived restorativeness and pro-environmental attitudes and behaviours. As green features increase the perceived restorativeness of a schoolyard (see Section 5.1.4), these findings suggest that greener schoolyards have the potential to improve students' relation to nature.

Although there are relatively few studies focusing on students' environmental orientation in relation to schoolyard design, the existing literature suggests a potential for green features (M1) to increase students' knowledge and care for the environment. Therefore, schoolyard redesign could become part of current effort to include environmental concerns into educational programs.

5.2 RQ2: factors facilitating and hindering student participation

The participatory process in the Cool City pilot project includes a set of three workshops to realize a diagnosis of the place, imagine future transformations and discuss opportunities and constraints (Figure 4). Students could sign up voluntarily after they were presented with the project in January. The first workshop was conducted in February with around twenty students aged 11 to 13 years old, the school dean, two teachers and social workers from the nursing home and the neighbourhood community centre. Other local actors were invited but could not attend. Due to COVID-19, the following workshops could not be conducted but are expected to take place sometime in the future. Students' involvement in future stages of the project (implementation, maintenance, etc) is to be decided through the process. It is also worth noting that the monitoring group managing the project includes a student representative since fall 2019 upon suggestion from the school. This role is fulfilled

by rotating representatives of the 'climate strike group', a self-organized group of students which emerged at the beginning of 2019 for coordinating their participation in climate strikes[8].

The next sections present my analysis of the factors enabling and constraining students' participation in the Cool city pilot project. These elements are related to the seven dimensions of my analytical framework (Table 1).

5.2.1 Opportunities for student participation

The qualitative analysis of the interviews revealed a range of interacting factors which enabled participation to be implemented within the project, in relation to the project's purpose (P1), the perception of youth and positioning of students (P2) and the school context (P6). In light of the definition of youth participation given previously (Section 3.2), elements which fostered power sharing in the process are also presented here, with regards to power relations (P4) and methods used in the project (P7).

To start with, participation was enabled by the purpose of the project. Although the main goal is the transformation of the schoolyard into a cool spot, reflecting the central issue of urban microclimate that the Cool City project tackles, it is also closely linked with the participatory dimension. One respondent highlighted this connection by stating that "it's clear that there's a goal, it's to transform something into a cool spot, but the goal is clearly to do it together".

Respondents also mentioned additional objectives which the project pursues. Firstly, by bringing actors together, the project aims at strengthening relationships within the local community. One respondent pointed out that "beyond that [tackling climate issues], what I see as a great strength of this approach is that we take advantage of the fact that we have to make transformations to create a community spirit". Secondly, respondents also emphasized that this project was an "experimental ground", which could serve as a learning experience for future projects. These two objectives also drove the implementation of a participatory process. Indeed, this process was seen as providing a

[8] Following the worldwide movement Fridays for Future, started by young activist Greta Thunberg in Sweden, climate strikes appeared in Switzerland in late 2018 and gained significant momentum in January 2019 with around 22'000 people, mainly students and young people, protesting in 15 locations around the country (Rippstein, 2019). Unlike in other Cantons, the DIP in Geneva supported the strikes by announcing that no sanctions would be held against attending students (Lugon, 2019).

platform for strengthening community bonds, while allowing for creative new ideas to emerge. This last point indicates that the incentive to foster participation may decrease in future projects.

Furthermore, the way respondents framed youth turned out to be a facilitating factor. Firstly, students were perceived as curious and creative people who "wouldn't be afraid of suggesting slightly odd things" and could have ideas which are "completely different from adults". Therefore, their contribution to the "experimentation" that would happen in their schoolyard was seen as highly positive. Secondly, the respondents drew connections between young people and the theme of climate change. The fact that young people are perceived as "wanting to talk about the climate" seems to have greatly facilitated their integration in the project and their consideration as legitimate actors.

Regarding students' positioning, one respondent explained that participation was part of the students' role "as citizen", an idea which facilitated the consideration of young people as worthy actors for the process. Considering the students as citizens meant that they had to "be involved, speak up, be an actor in the different projects that affect them". The respondent added that the project could also be part of a "learning process of citizenship".

Analysis also revealed that students' positioning within the project was closely linked the conception of students as "users" of the schoolyard. This perception facilitated their integration, provided that users are seen as key informants to create a project in line with local needs. One respondent emphasizes that "the project has to be adapted to the users, so the only way of achieving this is that these users are consulted and that they can express their needs".

Moreover, this framing facilitated power sharing between students and other adults participating in the process, such as teaching and administrative staff of the school. Since all these actors were seen as equal users, respondents emphasized the importance of challenging existing school hierarchies so that all participants would be on the same level. One respondent explained:

> We really encouraged teachers and staff working at the school to participate too because, either way, they are users of the school, just like the students. … They were here to discuss, like the public really had a horizontal positioning, so that the hierarchy which clearly exists within the classroom walls would be cancelled during the workshops.

In this regard, respondents pointed out the crucial role that the school played in fostering this dynamic, suggesting that the pre-existing relations are key factors to allow power sharing in the process. While one respondent was "amazed to see how the school played along … to really listen to these young

people", another one noted they were "lucky to find an atmosphere already so great", which they described as "very united, very family-like, very friendly". The role of the school board and teachers in driving participation is also seen in the way the process emerged. One respondent indicated that

> it's the school who asked how they were going to be involved in all this process, which made us think of the best way to discuss with them, whether the dean, the teachers or the students. … the answer which was given was the participatory process.

The design of activities can also be a critical factor in promoting or hindering power sharing. Respondents acknowledged this by pointing out that methods influenced how comfortable and confident the students felt. The variety of activities in the first workshop (discussions, drawing, walk around the neighbourhood) was judged positively by the respondents as it enabled students to actively contribute and was adapted to their age.

Moreover, opportunities for the students to take ownership of the project were planned, as the open community workshop and open class day would be organized by the students themselves. Regarding the design of all activities, the contribution of urbz and the Consultation Unit, as actors specialized in participatory process in urban planning, was significant. Engaging such actors thus appeared to be a strong facilitating factor, as their focus is not only on the physical outcome of the project but also the quality of the participation process.

Finally, the analysis did not reveal any element connected to the dimension of protection (P5), suggesting that respondents did not perceive any risks for the participating students. Indeed, the project did not address illegal or dangerous activities, and was set in the safe place of the school. This aspect may also have facilitated the implementation of a participatory process.

5.2.2 Challenges and constrains to student participation

The analysis also revealed limiting factors in regard to implementing participatory process and fostering power sharing. This section presents challenges experienced by respondents in regard to positioning (P2), perspective (P3) and place (P6). I also highlight the ways these challenges were addressed by project leaders.

First, one respondent explained that challenges could arise from the positioning of experts, as participation altered their practices and vision of their job. They noted that as engineers and urban planners "were trained as experts", it was "not easy to question that and to make space for others, to

try to articulate this without feeling endangered, called into question, frustrated as well". However, they explained that actors working on the Cool City project were quite open about this process and that their attitude was important for the success of the process.

Moreover, engineers and urban planners kept a position of knowledge and guidance within the project, by bringing their expertise to the workshops. In this context, power sharing between participants and planners was possible to a certain extent by fostering accountability. One respondent emphasized that they wanted to make sure "that elements brought up by the participatory process are effectively considered … and that we can answer and be accountable for what they take and what we don't take".

Another challenging point appeared in regard to the diversity of the student body. While the climate strike group was integrated in the early stage of the project, respondents noted that it was important that the process remained open to all students. Therefore, presentations in class were held to make sure all students be informed about the project. They could then sign up for the workshops on a voluntary basis. This process seemed successful to the extent that not all participants in the first workshop were part of the climate strike group. However, it is worth noting that the project still caters to a specific group of students: those who were "the most motivated and the most interested in the topic" and were available outside of school hours[9]. Therefore, the students participating in the project should not be understood as a group representative of the whole student body, especially since, as one respondent noted, "it's really nothing 20 students out of 600".

Finally, while the school was identified as a facilitating context, it also created some constraints on the process. One respondent explained that it could be "a little bit difficult to adapt to the requirements and the timeframe of the school". In this regard, workshops were scheduled to attract the most students while respecting the schools demands. This restricted the access for other potential actors from the neighbourhood, as many were not available during afternoons. This context may have also limited the participation of students that have a more conflictual relation with school or simply "want to do something else, rather than ending up again at school".

[9] Two out of the three workshops were scheduled on Wednesday afternoons, when students normally have no class, as the school did not want students to be missing too many classes.

6 Discussion

6.1 Schoolyard design for climate adaptation and educational goals

The literature review conducted in this study revealed the potential of heat-reducing measures in schoolyards to contribute to students' wellbeing on several dimensions (physical, social, psychological, cognitive and environmental). The reviewed studies also highlighted connections between these different domains (Figure 7), suggesting that co-benefits could reinforce each other. Thus, this study uncovered synergies between education and climate adaptation which could be harnessed in future projects. Although they were not excluded from the search criteria, no significant co-harms were found through the review. While this suggests that redesigning schoolyards in a climate-adapted fashion is a low-risk policy, it is worth noting that a large part of the literature explored was written with the explicit or implicit goal of promoting schoolyard greening initiatives, and thus focused on positive impacts.

The review also highlighted differences between the various types of heat-reducing measures (Figure 7). Green features (M1) were found to be the most studied type and presented the widest range of co-benefits. Among these, trees appeared to be more beneficial than grassy areas with regard to cognitive development and restoration. Vegetation diversity was found important for restoration, diversity of play activities and environmental knowledge. More extensive vegetated areas comprising trees, shrubs, but also hilly terrain and additional natural features appeared particularly beneficial.

None of the study reviewed investigated specifically the impact of blue features (M2). However, a few case studies investigated schoolyards which included a pond or a stream (Chawla et al., 2014; Harvey, 1990; Hodson & Sander, 2017; Samborski, 2010; Stanley, 2011). Although the specific impacts of the water body cannot be distinguished from these of the surrounding vegetation, co-benefits were observed in regard to student uses, preferences and environmental orientation. Theories about the role of nature on children's development also support the idea that natural blue measures could have similar impacts as green measures (Kaplan, 1995; Ulrich et al., 1991). The impact of build water structures, such as fountains or water mister, remains unexplored.

Research on other measures (M4) was scarce. With no surprise, shade sails were found beneficial against UVR exposure, but no studies investigated other potential co-benefits or co-harms. As trees can also provide shade and appear to entail a larger range of co-benefits, this study suggests that,

where possible, trees be preferred over built shade structures. This recommendation is consistent with the FOEN report in regard to the efficiency of various heat-reducing features (FOEN, 2018, p. 74).

Finally, one recurring aspect in many studies was the potential for green schoolyard to be more than just a recess area, as they can create opportunities for new forms of learning (Bell & Dyment, 2008; Chawla et al., 2014; Harvey, 1990; Kopeva et al., 2017). In this regard, activities such as gardening and outdoor classes have also been found to be highly beneficial for students' wellbeing, learning experiences and environmental awareness (Becker et al., 2017; Berezowitz et al., 2015; Blair, 2009; Chawla et al., 2014; Jacobi-Vessels, 2013; Maller & Townsend, 2006).

6.2 Fostering participatory schoolyard (re)design

Although the literature review considered solely the impact of the presence of heat reducing measures, co-benefits might actually highly depend on the cultural and school policy context (Bell & Dyment, 2008). Thus, the implementation of heat-reducing measures may not guarantee that their potential co-benefits are realized. Rather, co-benefits depend on how measures are planned, implemented, used and managed over time. In that regard,

> the benefits are not only connected to the green grounds per se, but also depend on participatory approaches. … Participatory, pedagogic and management activities can therefore be expected to influence the benefits of school ground greening (Jansson et al., 2014, p. 167)

In this regard, research indicates that involving students in all stages of schoolyard redesign is highly beneficial (Derr & Rigolon, 2016; Dyment, 2008; Jansson et al., 2018; Mannion, 2003; Wake, 2015). In the Cool City pilot project, students were involved through participatory workshops which aimed at understanding the current uses of the schoolyard and defining of a collective vision for the project. My analysis revealed that the implementation of this process was facilitated by the objectives of collective decision, community building and experimentation, the perception of youth as creative and concerned about the climate, the position of students as users, the favourable attitude of the school staff and the engagement of participation experts. Power sharing between young and adult participants was also facilitated through the methods used and the pre-existing positive relations within the school. Therefore, this study suggests that opportunities to foster youth participation in schoolyard redesign are manifold, in particular when such projects are related to climate issues and engaged actors recognize the capabilities of young people. It also confirms previous findings which have emphasizes

the role of supporting adults in fostering meaningful participation (Breitbart & Kepes, 2007; Checkoway, 2011)

However, challenges to the implementation of youth participation remain. While students' diversity was acknowledged and addressed by organizers, engaging a broad range of students is difficult. Participation also challenges experts' position and requires specific arrangements to ensure students' voice will effectively be heard. Finally, while the school context provides direct access to students, it also brings practical constraints on the possibilities for participation.

6.3 Limitations of this study

As this thesis focuses on the potential of climate adaptation projects in the school context, the findings indicate opportunities for harmonizing educational and climate goals. However, this study did not measure actual co-benefits in the case study, largely because the Cool City pilot project is ongoing. While the present study can orient the choice of measures and help advocate for the project, an assessment of the actual impacts on the long-term is warranted to examine to which extent co-benefits are realized and what factors can reinforce or impede them.

Such an assessment would also be useful to reveal differences linked with the purpose of the project. Indeed, the reviewed studies through which potential co-benefits were identified differ from the case study. Although the selection criteria for the literature review were designed so as to assess the impact of heat-reducing measures, more research is needed to evaluate how schoolyard design for the specific purpose of climate adaptation can create other co-benefits and/or co-harms. For example, while the presence of green features can increase students' orientation, this effect might be reinforced when the project specifically targets climate issues. Additionally, the potential of such projects to help students deals with climate anxiety could be explored, as this phenomenon is increasingly recognized as an important concern for youth's psychological health and taking action and creating supporting groups is recognized as a potential solution (Pihkala, 2019). Furthermore, this study focuses on the impact on students as the primary beneficiaries of schoolyard redesign. However, the project may also impact other actors, such as teachers and school staff, as well as local residents. Evaluating these impacts is crucial to develop projects which can also contribute to a better work environment and community space.

The design of this study also means that findings in regard to students' participation only reflect the perspective of project leaders. While this perspective is useful for identifying factors which might

encourage or prevent public officials from engaging with youth (Lekies et al., 2009), it provides limited insights on how the process is experienced by the participants. In particular, integrating the perspective of students is critical to obtain a more comprehensive view of the process. This would be useful to identify potential barriers and strategies to encourage more students to participate. Discussion over the potential of participatory process to foster power sharing would also greatly benefit from the integration of all involved parties in the research. This aspect could also have been better addressed if power dynamics in the workshops could have been observed. These two elements, observing workshops and interviewing students, were originally planned for this research but could not be conducted due to COVID-19.

Finally, I acknowledge the limitations of the co-benefit approach which I adopted in this thesis. While this approach has great potential for advocacy, critics have pointed out that its focus on win-win strategies tends to hide trade-offs (Mayrhofer & Gupta, 2016). This focus can also steer efforts away from addressing the root causes of climate change (Mayrhofer & Gupta, 2016). While these shortcomings are particularly clear for climate mitigation as well as development policies in the Global South, this does not mean that it should be completely discarded (Mayrhofer & Gupta, 2016). As climate adaptation does not by nature targets the roots of climate change, the co-benefits approach can still provide useful insights for developing more integrated policy, provided that co-harms and trade-offs are also considered.

7 Conclusion

As heat stress puts increasing pressure on urban populations, policy makers and urban planners have to rethink the design of our cities to account for climate change impacts. In this context, this thesis considered school grounds as a strategic arena for intervention in urban climate adaptation. Based on a case study of a schoolyard transformation project, this thesis concludes that policies addressing the UHI effect can be successfully combined with the development of healthier and more engaging school environments for children and teenagers living in urban areas. These findings can help advocate for the implementation of heat reducing measures, in particular vegetation, in the redesign of existing schoolyards as well as in the development of new school grounds.

This thesis also highlights the potential and opportunities for students' participation in the design of these spaces. As participation can be beneficial to the students' own development as well as the improvement of their daily environment and communities, this thesis indicates pathways to enable students' meaningful contribution to schoolyard design. While the purpose and context of the Cool City project facilitated students' involvement, the role of adults in fostering participation and power sharing is also crucial.

Further research is warranted to measure the actual co-benefits of schoolyard transformation with the purpose of heat reduction. Furthermore, trade-offs and barriers to implementation should be investigated in order to understand the limitations that schoolyard transformation as a climate adaptation strategy faces. Finally, engaging with students is needed to fully comprehend what enables or limits their involvement, as well as how they experience participation.

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Appendix

Appendix I. Actors involved in the Cool City pilot project in Sécheron

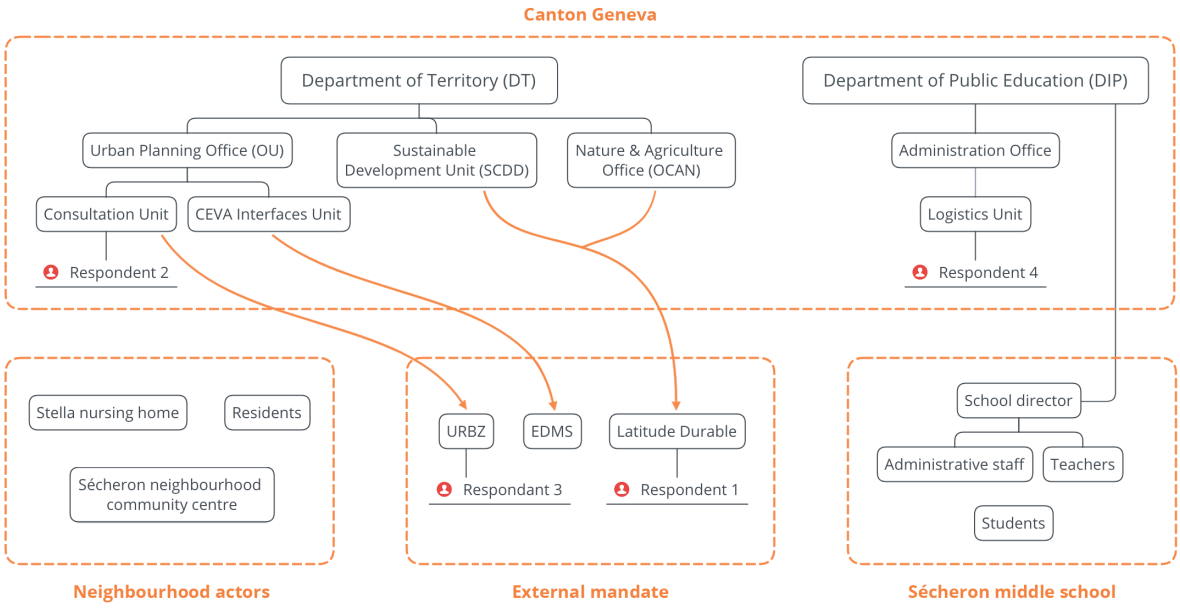

Figure A-1. Organisation chart of the public and private actors involved in the Cool City pilot project at Sécheron middle school, including interview respondents. (Own illustration).

Appendix II. Search queries for RQ1

All queries were performed on Scopus and Web of Science between February 27th, 2020 and March 2nd, 2020. Searches were conducted on title, abstract, and keywords (option TITLE-ABS-KEY in Scopus; TOPIC in Web of Science)

M1 – Green measures (128 unique results)

(tree* OR green OR vegetat*) AND (schoolyard OR "school yard" OR "school ground")

M2 – Blue measures (74 unique results)

(blue OR water OR pond OR river OR fountain OR wetland OR lake) AND (schoolyard OR "school yard" OR "school ground")

M4 – Other measures (33 unique results)

(shade OR albedo OR asphalt OR reflecti*) AND (schoolyard OR “school yard” OR “school ground”)

Appendix III. Interview guide

Table A-1. Interview guide. A French version of this guide was used to conduct semi-structured interviews with key actors within the Cool City project. Respondents were informed about the purpose of the research and gave oral consent to the use of the collected data at the beginning of the interview.

Theme		Questions
Cool City pilot project	Role of the respondent	What is your role in the project? What is the role of your institution/company in the project?
	Tasks and involvement	What part of the project have you been involved in?
	Goals and objectives	From your point of view, what is the main goal of the pilot project? Are there any additional objectives that the project could contribute to?
	Benefits	From your point of view, how will the project benefit the school and its students?
Participation	Planned process	Have you been involved in designing (or been part of any decision regarding) the participatory process? **If yes:** How have you been involved? Concretely, how is the planned participatory process going to take place? What are the planned activities? Who will be involved? How are these people chosen? → always ask for the reasons (why?) **If no:** Will you take part in the participatory process?
	Goals and objectives	What do you see as the goals of the participatory process as it is planned? What are the advantages/challenges of conducting a participatory process for the project (compared to other forms of governance)?
	Participation in previous projects	Do you have previous experience of participatory processes for projects within your institution? **If yes**: was the procedure always more or less similar? Which elements, if any, have been tailored to this particular project? Are there any differences due to the participation of young people (compared to adults)? **If no**: why was it decided to hold a participatory process for this project in particular?
	Opinion about the project	From your perspective, what are the strengths of the project / challenges within the project ?