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Making Green Heritage Schools Work: Nature-Based Solutions and Historical Preservation When Infrastructure Fails

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Abstract: Schools provide strategic resources for urban sustainability. An international, interdisciplinary research agenda documents the social and ecological benefits of living in green or re-naturalised schoolyards, a hybrid format of urban nature-based solutions. Focussing on low- and middle-income countries, where implementation lags, this paper addresses the challenges of replicating and scaling successful pilots. A better understanding of capacity building challenges is crucial, considering that schools face several concurrent challenges, including historical preservation of heritage buildings, universal access provision, and infrastructure failure in ageing facilities. This study presents primary evidence from action research to build and promote living schoolyards in Argentina, structured as a comparative case study of attempts to co-develop yards with two schools in Buenos Aires. One was an older school with historical preservation status; the other was a more modern, larger school with relative heritage value. Findings show contrastive outcomes. Our programme advanced only in the former. Historical preservation regulations posed relatively manageable contingencies, whereas insurmountable obstacles came from poor general maintenance and governmental risk aversion. Concluding remarks make suggestions on how to co-design projects with communities to synergise heritage schemes, creatively fix infrastructure deficits, and stir a mindset shift for decision-makers to understand and value urban re-greening.

Keywords: living schoolyards; green fences; landscape architecture; sustainability planning; nature-based education; infrastructure failure; urban heritage; Latin America; urban ecology

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1. Introduction

Recent research on living (re-naturalised or re-greened) schoolyards highlights the multiple social and ecological benefits that this type of nature-based solution contributes to urban environments to improve their sustainability [1–6]. The design and management of schoolyards as 'living' neo-ecosystems builds urban resilience to the climate crisis by installing hybrid configurations of grey, green, and blue infrastructure. The approach also improves the liveability of the yards, which are heavily used by sensitive populations such as young children and teenagers.

A growing international literature documents the multiple and varied contributions of living yards. These include but are not limited to shifting to permeable surfaces to increase the absorptive capacity of cities to reduce rainwater runoff [7,8]; mitigating heat island effects and serving as a community refuge during heat waves by providing shade and cooler temperatures [9,10]; realising biodiversity gains and supporting on-site nature-based learning, which may inspire the next generation of urban environmental advocates [11–15]; improving student well-being and academic performance [16–30]; and reducing the school community's exposure to noise, visual, and air pollution (especially by filtering pollutants from near-by traffic) [31–37]. Furthermore, a thriving network of living schoolyards could

become a pillar of a discontinuous areawide sustainability strategy for densely built, older, and heterogenous urban built environments [38].

The untapped potential of living schoolyards and other urban nature-based solutions is considered a major research priority for low- and middle-income countries [39]. Yet, policy implementation lags [40–42]. In these geographical settings, infrastructure deficits and failures extend to the inadequate management of insufficient urban vegetation [43]. An unreliable supply of water and electricity also impinges on the development of hybrid nature-based solutions, which may require automated watering systems at least during parts of the year. Compounding the problem, there may be a lack of adequate and well-maintained building space in schools that is suitable for pedagogical activities and the everyday needs of diverse school communities—including universal access and age- and gender-specific spaces for play and recreation [44,45].

Several pilot projects have emerged, the above problems notwithstanding [46–48]. Such experiences provide proof of the concept that adding a living yard component to struggling schools is indeed possible and help understand the strategies required for the wide implementation of at least some modular aspects of the living schoolyard model.

Yet, the challenge of substantive policy adoption remains, calling for insight on how to move beyond research documenting site-specific benefits to generate enough momentum for decision-makers to value living schoolyards and scale up the model to a larger number of schools with various built environments and social configurations. Undoubtedly, this will require multiple planning supports, including a detailed cost structure for building and maintenance; an aggregate estimation of total benefits extending to cost savings in future healthcare needs and disaster risk management; and a fine-grained understanding of the citywide stock of built and open space in schools [49].

This paper focusses on shedding light on the latter. We argue that the varied cultural landscape of densely built cities and their schools offers a clear area of opportunity, even if it poses its own challenges both in terms of its built environment and associated social and policy practices. Adequately understanding the availability and characteristics of the built and open space within city schools entails distinguishing between different architectural typologies and site plans.

In historical, densely built urban cores, where deficits of green open space may be most acute, variability across schools is evident. Different schools were built at various times in history. Compounding this complexity, some of the older schools may carry heritage value and even be listed for historical preservation. Previous research shows that while heritage value may be synergistic with urban nature-based solutions, connecting people and nature through the past, present, and future, regulations on listed schools may complicate their retrofitting for sustainability purposes [41].

While the agendas may be mutually reinforcing, concerns may also arise that added vegetation complicates the conservation and management of historical buildings [50]. Here, too, for cities in low- and middle-income countries, infrastructure failure mediates the relationship between nature-based solutions and urban heritage [43]. Systemic deficiencies in the historical preservation of schools may deepen the complexities of developing green infrastructure in synergy with their heritage protection. Poor maintenance of existing indoor and outdoor spaces may increase construction and maintenance costs of ancillary green infrastructure, reduce overall social and environmental benefits, or even prevent their development altogether.

This paper's main aim is to produce practical insights into the specific challenges and relative benefits of leveraging yard spaces in schools with historical preservation status to promote this model of urban sustainability. The paper draws from a multi-year action research project to build, experiment with, and promote the use of living yards in Buenos Aires, Argentina [46,51]. While some of the challenges encountered were highly specific to this Latin American research context, which is beset by multiple economic, social, infrastructure, and environmental challenges, our findings on the relationship between heritage and sustainability urban agendas under the shadow of infrastructure uncertainties,

deficiencies, and breakdowns should be of interest to both researchers and practitioners concerned with making schoolyards more adaptable, liveable, and inclusive.

2. Materials and Methods

This paper draws its main findings from the Breathe/Respirar Project (BRP). BRP is an action research programme that has been seeking to connect people and nature in dense urban environments since 2017. The programme focusses on schoolyards as strategic intervention sites to advance urban sustainability. Its objectives include producing multiple social and environmental benefits in the fields of education for sustainable development, health and well-being, urban biodiversity, and citywide resilience to worsening heat waves, torrential rains, and other consequences of the climate crisis.

With the initial objective of re-designing a British model of green fence provision for near-traffic schoolyards [52,53] to adapt it for implementation in an Argentine context, the BRP has evolved into an interdisciplinary effort to comprehensively re-green schoolyards in Buenos Aires, the national capital and centre of the country's largest metropolitan area. The goal is to make the schools more liveable and able to contribute to a biodiverse, living city. Proposing an innovative model for the research and practice of landscape architecture in Argentina, the programme brings together an international team of social, behavioural, and environmental scientists who work alongside design professionals to build, manage, and research living schoolyards in co-production with concerned school communities [51].

While labour intensive and requiring long time spans, BRP's model of 'learning by doing' action research was required for Buenos Aires, Argentina's largest and capital city, given the lack of previous examples of site-specific green infrastructure refurbishments at schools [54]. Previous research also forewarns a glaring gap between policy discourse and actual practice in the field of nature-based solutions and urban environmental policy in general [55–57].

The analysis is structured as a comparative case study (CCS) of experiences in working with two schools in Buenos Aires to re-green their yards [58]. Widely used in the field of international educational research, the CCS method's focus on process and attendance at the macro, meso, and micro scales allowed us to draw inferences from the contrasting (current) state of each initiative and the respective factors influencing it. For our study, we conceptualise the micro-scale in regards to the schoolyards; the meso-scale relates to the school as an integrated facility and managerial unit; and the macro-scale refers to the schools in the context of the city government (Ministry of Education) and building and environmental regulations. In addition to the primary data generated through our action research, we conducted a survey of secondary data, including a review of statutory zoning (Código Urbanístico y de Edificiación) and historical preservation regulations as they apply to both schools [59,60].

The cases compared include the first living schoolyard pilot ever built in the city and a second school selected to test the replicability of the model and programme scalability. Both schools are city-run and participate in an innovative governmental programme to pursue sustainability improvements to produce 'green schools' [61]. Yet, as the analysis below shows in more detail, built in the 1940s, the first school has a historical preservation listing, while the second school, built more recently (1980s), does not—even if its architectural style and programmatic features are recognised as of heritage value among certain urbanist circles.

Our CCS is presented sequentially for the yard at the first school (from here on, 'Medone'). As already stated, the BRP's initial pilot in Argentina was refurbished several months before planning at the second school (from here on, 'Cacciatore') even began—Figure 1 shows a map of the City of Buenos Aires with the relative locations of Medone and Cacciatore. Using our field notes, meetings, and communications records, we have constructed a timeline for each process to evaluate the multiple factors influencing it, respectively. Additionally, we have carried out surveys, semi-structured interviews, and multiple interactive activities with stakeholders in both schools and city government offices.

At each school, we interviewed school headmasters, teachers, custodians, and parents who were involved with the PTA (*asociación cooperadora*). With research funding, a community liaison was hired at each school to be able to explain the project more directly and in simple terms to stakeholders and communicate their questions and concerns back to the research team. Participation in all interviews, focus groups, and workshops took place with informed consent (with an information sheet and signed consent form in Spanish provided in all cases) and following both British and Argentine standards for ethical research as detailed in the paper's back matter.

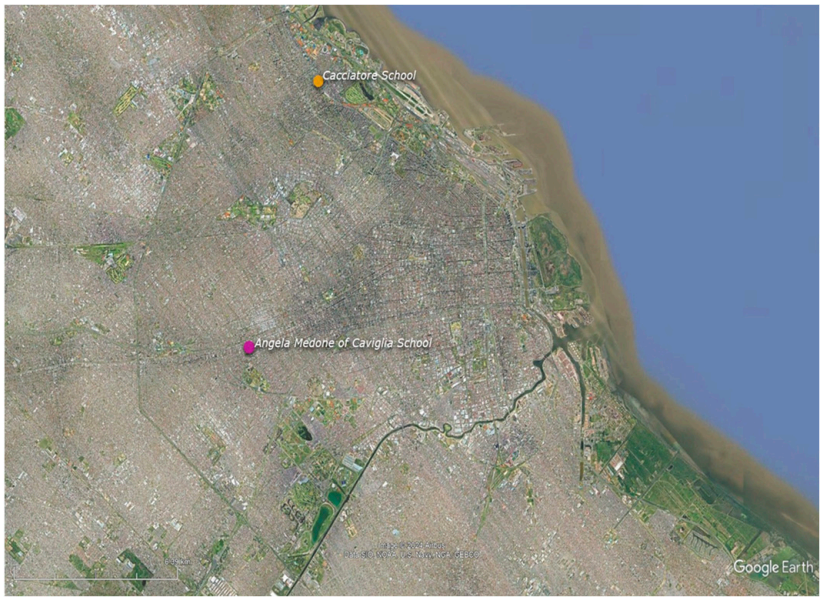

Figure 1. Map of the City of Buenos Aires with the relative position of both schools. Source: Authors' own image based on data from Google Earth. Available online at: https://earth.google.com/web/ (accessed on 1 August 2024).

3. Findings

3.1. The Medone School: A Living Yard for a Historical Preservation Building

The Medone school (formally named Escuela N° 3. D.E. 11. Angela Medone de Caviglia) was founded in 1897, at a time of rapid population growth and urban expansion, but its current building was only completed in 1946 with a private donation that bestows the school's name to this date. Located on a busy block of the lower–middle-income outer Western neighbourhoods of Buenos Aires, the building features a 'neocolonial' architecture with a characteristic façade of white walls and limited ornamentation alluding to the Hispanic origins of Argentina as a nation. Figure 2 shows the neighbourhood context of the school.

The Medone school was listed for historical preservation in 2009 (Resolución 610/BO 3396). It is designated as a "singular building: representative property" with a "cautionary" (lowest) level of protection regulations [62]. It is noteworthy that Medone has this designation even if it is not located within one of the various *Areas for Historical Preservation* that the city government has established for Buenos Aires to prioritise historic preservation efforts. Cautionary protection refers specifically to renovations to the building and does not include open areas.

We received permission to plant in the front yard portion that is assigned to the school's kindergarten programme. This permit was granted relatively swiftly, considering the bureaucratic delays that may occur in the governance of city schools. Only four months passed between the initial identification of Medone as an opportunity site for the action and our initial plantation in November 2019.

Figure 2. Aerial view of the Medone school neighbourhood context with the school ground in purple highlight. Source: Authors' own image based on data from Google Earth. Available online at: https://earth.google.com/web/ (accessed on 1 August 2024).

During this time, the BRP engaged school managers, teachers in the kindergarten programme, parents, university students, and multiple other volunteers who helped with the design and installation of the initial vegetation module. While the BRP team carried out a survey of baseline environmental conditions, we received substantive collaboration from the city government in conditioning the site. City employees retired an overgrown, hazardous, non-native ficus tree (*Ficus benjamina*) that occupied the middle of the yard and shaded it permanently, creating risks of structural damage from its roots and making play in the yard unpleasant and hazardous, as reported by both teachers and families.

A major hurdle appeared when city authorities communicated that the automated watering system that had been planned could not be installed due to alterations and potential damage to the building's front wall. The BRP team decided to proceed with a manual system until a more permanent solution could be found. This delayed plant growth and entailed additional costs, especially in the summer of 2019–2020, a period of high heat in Buenos Aires, where the recently planted yard had to be watered manually, with a major contribution from school groundskeeping personnel volunteering their time, and with occasional, unofficial support of hydrant trucks.

After numerous meetings, the Department of Education (infrastructure division) approved the installation of a bespoke watering system. In May 2022, we were able to install minimally invasive (and removable) piping to connect a water tank nested on the building's roof to the living yard. This was deemed to not alter the building's historically preserved structure. Importantly, the additional watering support allowed us to expand the vegetation coverage and add the biodiversity corner featuring a small butterfly garden.

3.2. The Cacciatore School: (Green) Infrastructure Failure in a Modern Facility

The 'Cacciatore' school (real name and exact location kept confidential to avoid any potential stigmatisation) was built in the 1980s as part of a large-scale programme of school construction initiated by Osvaldo Cacciatore, the city administrator during Argentina's military dictatorship (1976–1980). The programme sought to build modern schools on larger city plots (of no less than 1500 m^2) and focused on acquiring land from existing parks, yards, and green open spaces. High-profile local architects were recruited to produce robust designs using reinforced concrete and brick. These were to follow standardised and modular rationalist patterns to accelerate construction and reduce future maintenance costs [63].

While these schools are collectively known as Cacciatore after their mastermind's namesake, and a certain appreciation of their heritage value has emerged, our project's Cacciatore school is not listed for historical preservation, even though a certain architectural appreciation of the Cacciatore schools has emerged [64]. As Figure 3 shows, the Cacciatore school is located in a dense, higher-income area of the highly sought-after city's northern neighbourhoods (the so-called '*corredor norte*' between *Santa Fe*/*Cabildo* and *Libertador* avenues). It features some architectural highlights, such as being built with a setback from the lot line, which allows for a double façade, which is rare in Buenos Aires. It has specialised spaces for curricular and extracurricular activities, including a rooftop with affordances for small-scale urban farming on raised beds. It evinces, however, the urbanist ideology prevailing at the time it was built [65].

Figure 3. Aerial view of the Cacciatore School neighbourhood context with the school ground in yellow highlight. Source: Authors' own image based on data from Google Earth. Available online at: https://earth.google.com/web/ (accessed on 1 August 2024).

The project's Cacciatore School has a minimal level of plants on the building's back side, which is disconnected from the rest of the facilities. Furthermore, inside the school's main hall, one gets a 'boxy' feeling of a loud and poorly ventilated space, which is compounded by the school's high enrolment and intensity of use. The authoritarian military regime, of which Osvaldo Cacciatore was part, believed in a 'functional' city, where higher-order economic functions were given priority over human well-being, spaces for socialisation, and urban vegetation. In fact, at the time, several plazas were built devoid of vegetation, and the value of green pockets in the city was forgotten, instead giving priority to a large-scale green belt to be developed around the city, also with the objective of improving its solid waste management treatment [66].

A group of parents from the Cacciatore school contacted the BRP team in February 2020. Their ambition was to replicate our recently built living schoolyard pilot at their school. They expressed concerns with the environmental quality of the school's only open-air play yard, which was built on a street corner and faced heavy traffic. With sufficient action research funding to support their goals, the team began a process of engagement, design, and planning approval.

While the school community as a whole showed major interest in re-greening the yard through a survey that concerned parents carried out with our support, and the school authorities supported the project, by December 2022, no progress had been made in terms of obtaining permissions from the city's Department of Education (School Infrastructure Bureau). The BRP was not even allowed to install low-cost, compact air-quality equipment to establish a baseline of existing conditions and support the installation of a minimally

obstructive green fence. Given the lack of progress, the team decided to put the living schoolyard project on hold and support the school's re-greening otherwise.

The school's infrastructure problems first became apparent in November 2021 when, after multiple rounds of discussions with city officials and adaptations to the project, the research team's request for permission to install six electric air quality monitors was denied. The official response was that due to the lack of upgrades to the school's electric board, even the small amount of additional electric consumption foreseen by our equipment would represent an overload hazard, leading to wiring overheating and potential fire damage.

A frustrated parent shared with our community liaison that the same response was given when, for three years, donated air conditioning equipment could not be installed in two upper-floor classrooms with direct exposure to the afternoon sun. In fact, this appears to be a generalised problem with educational infrastructure in the city, as evidenced by an accident that took place in February 2022. At a different school, with similar characteristics to the Cacciatore and also participating in the city's sustainability programme, a worker sustained second-degree burns when attempting to install a solar panel on the roof. An electrical surge caused the wiring to blow up and catch fire [67,68].

Further complications occurred in our co-designed attempts to re-green the Cacciatore school. Given the lack of permits to intervene in the yard, we put together an alternative plan in collaboration with engaged parents. This was intended to support the rooftop food planting, but it has also been postponed due to problems with the roof leaking. More recently, a new postponement occurred in relation to a project to install a lift for a student with a mobility impairment. The city was legally required to provide access. Our community liaison reported that constructors took over the roof during the project, closed it off to general access, and took away the planting beds.

3.3. Paradoxical Results: Contingencies Overcome, Unforeseen Barriers

The core finding from the sequential CCS analysis presented above is that in over five years since the start of the action research programme, current conditions are far more encouraging at the Medone school. Starting in 2019, we were able to co-design and build a living schoolyard within a year. In collaboration with the school, city government, third-party volunteers, and various collaborations with both Argentine and international researchers, our team has been able to support the everyday life use of the living schoolyard; expand its functionality and make adaptations in ongoing dialogue with its changing users (kindergarten enrolment changes yearly); monitor co-benefits; and carry out periodical maintenance since (see Figures 4 and 5 for images of the yard before and after the intervention).

Figure 4. Image of the yard at the Medone school prior to the BRP intervention, showing the site's sparse vegetation and degraded soil. Source: Authors' own image.

(**a**) (**b**)

Figure 5. Images of the current conditions at the Medone school's living schoolyard feature (**a**) the improved outer perimeter and biodiversity area and (**b**) improved soil with wooden chips. Source: Authors' own images.

We have progressively expanded the living yard functions—a biodiversity corner and sustainable playground surface were added to the first phase focused on re-greening the outer perimeter. We have mobilised it to produce community co-benefits—improving the well-being of children and teachers, providing a suitable space for nature-based learning, and enhancing the neighbourhood's street appeal. The Medone schoolyard also helps us to carry out life lab activities to measure, document, and communicate the benefits of site-specific urban nature-based solutions by, for example, carrying out air quality and ambient temperature monitoring.

This has been achieved through an ongoing collaboration with the school community. Just to mention a noteworthy example, one parent happily reported that it now took a bit longer to pick up their young child from school as he would now run and 'hide' in the garden after class. In a focus group on how to improve the intervention, a group of other parents expressed concerns about their children's footwear getting 'muddy' in the garden—which is not trivial for lower-income families with fewer resources—and concerns with stigmatisation around cleanliness. This led to the installation of wooden chips, which we obtained as a donation from the city's recycling facility, to create a sustainable, safe, and relatively mud-free playground in the middle of the garden.

Meanwhile, results at the Cacciatore school indicate the numerous barriers that need to be considered to escalate the model and build living schoolyard capacity in Buenos Aires, especially for schools that may require any kind of structural modification to refurbish their yards to implement the model. Our timeline above shows that starting in early 2020, it took close to three years of unfruitful discussions, stakeholder engagement, and proposal revisions until the BRP team finally decided to shift plans in December 2022. While we continue engaging with the school to support their re-greening aspirations, no physical intervention has taken place to date, and prospects for improvements in the near future remain complex.

These contrasting outcomes appear paradoxical at first sight. The BRP's efforts, despite several contingencies and delays, have resulted in a more encouraging outcome at the Medone School, which presented lower initial odds of a successful intervention. This includes, but is not limited to, older facilities and more complex regulations, given its historical preservation status.

At the larger, more modern Cacciatore school, we faced a more promising start. We had accumulated experience in the challenges of action research and a proof of concept that

a group of parents learnt about and actively sought to implement at their school. Yet, we have faced unforeseen and, to date, insurmountable barriers.

Despite an initial agreement, a final city government permit (from the Department of Education's infrastructure division) to intervene is yet to be produced due to concerns with the structural modification required to re-green the impermeable schoolyard surface and the additional burden that the refurbished green yard may place on the school's electric wiring. Figure 6 shows the current state of the yard without intervention to date.

(**a**) (**b**)

Figure 6. Images of conditions at the Cacciatore School show (**a**) the yard as initially found and continuing without re-greening intervention to date, and (**b**) the current general view of the school front with work in progress to install a lift. Source: Authors' own images.

It is important to note that the COVID pandemic affected both processes as it had major impacts on Argentine social life, but the strictest lockdowns and school closings lasting almost a year from 19 March 2020 affected each project differently. While planting at Medone could be carried out before the lockdown, school closures meant additional logistical challenges to keep the plants sufficiently watered and maintained. Several workshops and focus groups with the Cacciatore community were carried out online for the same reason. Participation was actually high, as teachers could participate from home and while carrying out other activities (with at least twenty staff members participating in each of the two sessions). Strict lockdown rules, whereby green open space was off limits and traffic decreased dramatically, led to a reappraisal of urban greenery and contact with nature, as well as cleaner air and decreased noise pollution with fewer cars in the city [69,70]. A survey run with parents at the Cacciatore school immediately after the lockdown received 90 responses, of which 98.9% agreed that learning in and with nature is important for the school's present and future, while 62.2% did not think that environmental awareness and protection were sufficiently integrated into the schools' curriculum.

3.4. The Nature of Schoolyards—Or Lack Thereof

Differences between the yards themselves help to explain the contrasting outcomes and point to the relative value that city administrators (at least in the field of school infrastructure) may find in green infrastructure and urban nature-based solutions (see Figure 1 for a comparative illustration of current conditions). On the one hand, the successful living schoolyard intervention at the Medone school took place in a relatively smaller yard (200 m^2), with 85% of its area already covered by a permeable surface (170 m^2). On the other hand, the Cacciatore schoolyard of 605 m^2 is fully covered by an impermeable surface (tiles over cement). Their baseline conditions were highly contrasting.

In contrast to the well-preserved building facade, the kindergarten's schoolyard was in poor condition prior to the BRP action. The overgrown tree in the middle, with its permanent shading, caused soil deterioration. Poor in nutrients, the worn soil had lost permeability, and it flooded easily at times of rain. Regardless of the specific socio-ecological value of the living schoolyard model (with some of the co-benefits harder to explain and demonstrate due to a lack of citywide official data), our intervention was widely welcomed as a general site improvement.

At the Cacciatore school, the play yard is used intensely throughout the day, starting with a salutation to the Argentine flag at the beginning of every school day and then during class breaks. Due to the school's high enrolment, different grades need to take breaks at alternate times. Furthermore, with its rectangular shape, the yard is used largely as a football field. A teacher mentioned that fewer older boys occupy most of the area, whereas girls and smaller boys have to stand to the side of impromptu, vigorous matches.

Even with the costs of refurbishment covered by BRP action research funding, school planning officials could not agree to replace a minimum amount of perimeter tiles with soil. Contrary to the evidence that we showed them about the lack of risk of infiltration (only debris below the elevated yard platform), they were concerned with the risk of structural damage. They also argued that the vegetation could be hazardous and take away vital child play space.

4. Discussion

Our action research in Buenos Aires indicates that the multiple benefits of living in schoolyards discussed in the (high-income nation-skewed) international literature hold promise locally and for other comparable cities in Latin America and local- and middle-income nations. In collaboration with the Medone School since late 2019, the BRP pilot living schoolyard has begun to produce evidence of the intervention's multiple benefits [46] and continues to function and expand as a site with value for both the local community and to monitor and further understand this hybrid model of urban nature-based solutions. Yet, it cannot be realistically expected that our ongoing engagement with a single site will be able to single-handedly demonstrate the multiple and variegated benefits documented in the growing literature, as these extend to realising biodiversity gains, supporting on-site nature-based learning, and improving student well-being and academic performance [11–30].

While also addressing the question of how to produce further systematic evidence, this paper's focus on questions on replicability and scalability aimed to produce insights in support of generalised policy implementation, considering the broad variability of schools and their yards in the city and the multiple concurrent challenges that their communities face. The core finding from the CCS at the Medone and Cacciatore schools' contrasting experiences is that, at least in the Buenos Aires context under analysis, the contingencies that historical preservation regulation presents to developing green infrastructure in schools with heritage value are relative. They were far less insurmountable than systemic problems resulting from infrastructure failure, generally poor maintenance, and a lack of understanding/valuing of socio-ecological benefits on the part of those managing the school infrastructure. In fact, this finding broadens the discussion on the complex relationship between heritage and nature-based solutions [41,50] and contributes to developing selection criteria for further living schoolyard development. Older heritage schools may present sites of opportunity as they are less likely to have been updated to follow more rational, standardised programming of modern school functions and may feature more open, permeable spaces with the possibility to install green infrastructure at a low cost and with less resistance.

As confirmed at the Medone school, once installed, the visual and aesthetic value of the heritage architecture can synergise the multi-sensorial benefits of living schoolyard modules, both benefiting the local community and promoting the action more widely for replication in other schools. Complications may arise, however, when seeking to expand the schoolyard's functions or to maintain it, especially during seasons when automated

watering is required—also considering that schools in Buenos Aires are closed in the most trying summer and there are fewer opportunities for manual watering.

The study's findings also speak to the question of community participation, which is seen as a pillar of successful urban nature-based solutions [1–6]. Our co-designs, both at the Medone and Cacciatore schools, received a high level of support from a varied number of stakeholders, including city officials in the field of sustainability, school administrators, academic and clerical staff at the schools, and families. Teachers' and parents' reports from Medone also indicate student approval and increased use of the yard. Nevertheless, whereas community support was essential for the project to thrive and overcome various implementation hurdles, including volunteering to water and care for the plants until more formal maintenance arrangements could be finalised, the experience at Cacciatore indicates that even a mobilised community, with parents actively requesting a re-greening of their school facilities, is not sufficient to progress projects unless initial governmental permission is obtained.

5. Conclusions

Beyond the achievements and challenges for the BRP team to promote living schoolyards in Buenos Aires (we have since worked successfully with a third school located in a different municipality of the metropolitan region and a university building and have several other living yards in the planning), the study presented herein has clear implications for urban nature-solutions in the heterogenous and uneven cultural landscapes of cities in low- and middle-income countries. In the context of infrastructure failure, characterised by deficits and breakdowns, the re-greening of indoor and outdoor spaces of the built environment and the broader pursuit of sustainability, including adaptation to the climate crisis, need to be understood in relation to multiple other governmental priorities and societal demands, such as preserving architectural heritage and securing universal access to basic facilities, such as schools, that will work reliably and effectively.

Interactions need not be limited to trade-offs and zero-sum games between priorities. The paper showed synergies at the individual school level, but it is worth exploring how the legal and institutional tools used for the historical preservation of city buildings and districts with heritage value may be extended to both their legacy and newly developed green infrastructure. This could include various classifications with their own specific regulations, as well as officially sponsored valorisation and awareness campaigns. It should not be limited to monumental parks but extend to small and even micro gardens that will enhance the value of historic buildings both in aesthetic and functional terms. More detailed stock-taking of open space availability in heritage schools seems worthwhile, both in Buenos Aires and elsewhere.

After decades of professional and community activism, architectural preservation can show certain achievements and institutional and practical gains, even in cities like Buenos Aires, with high economic growth pressures to promote real estate development [71,72]. Likewise, the promotion of variegated formats of urban vegetation as a city's long-term assets requires committed champions. As the BRP shows, to be most effective, this task cannot be limited to landscape designers but also needs input from a wide variety of design, social, and environmental science disciplines. This paper's most sobering conclusion is that a transition from grey to green in urban infrastructure may not still be a widely shared aspiration, and there is much work ahead in demonstrating its benefits to decision-makers in various fields.

Finally, the question remains on how to best secure community support and social mobilisation around urban vegetation as a (green) infrastructure that requires investment and maintenance. On a larger scale of policy activism, this will require raising awareness about the urgency of making urban cultural landscapes more resilient to climate change. Effective messaging is required to show that nature-based solutions will support, rather than compete with, societal demands, such as universal access to high-quality education in livable/living environments that will support health and well-being alongside academic

achievement. At the project level, our study indicated that effective co-designs will respond to the highly specific perceptions and desires of diverse stakeholders. This will increase the odds that at least some of them will volunteer their time and effort to keep projects alive when all other means fail.

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