Nature-based Education

A guide for greener and more resilient schools

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CODINA, Joaquim José. [Ambelania tenniflora, Müll], 1785. Drawing, watercolor, 26.5× 17 cm.

Preface

UNKOWN ARTIST. [Anona], n.d. Drawing, watercolor, 26.5 × 17 cm.

Schools face an urgent challenge: the need to adapt to socio-environmental crises. This is especially true of the climate crisis, which already directly affects children and the broader school community.* Increasingly frequent and extreme events — such as heat waves, landslides, droughts, and floods — are disrupting education, threatening not only teaching and learning but also the physical and emotional health of students and educators.

The climate emergency is no longer a distant prediction; it is an everyday reality for children and adolescents. Their stage of development makes them especially vulnerable, and they feel its effects more intensely.

Schools play a strategic role in this context. They are numerous and widely distributed, central to the lives of children and families, part of everyday routines, and vital spaces for community life. They also form part of the social protection network and serve as centers of knowledge and culture. Preparing these institutions for climate adaptation is therefore essential. This requires systemic, cross-sector action that addresses both the everyday operations and emergency response, including contingency planning, resilient architectural design, environmental regener-

* [EXPLANATORY NOTE] Throughout this guide, we use the definition of “child” from the United Nations Convention on the Rights of the Child, which applies to every human being under 18 years of age.

ation of surrounding areas, recovery of pedagogical activities after disasters, and mental health support in the face of trauma, loss, and irreparable damage.

Adaptation is not only about worst-case scenarios but also about the everyday effects of climate change on school life. Here, Nature* emerges as a fundamental ally. Greening school spaces makes them more resilient while also addressing the lack of contact with Nature in children's lives. In turn, this supports holistic development and enables a living curriculum rooted in care and critical awareness. Together, these benefits reinforce the right to a quality education that promotes health and well-being.

School environments with permeable ground, shade, greenery, and good ventilation provide thermal comfort, reduce stress, and improve focus. Reimagining and regenerating the places where children spend much of their day is therefore a matter of rights: the right of children and adolescents to a healthy environment. Access to Nature and outdoor experiences in daily school life is not just an environmental or pedagogical benefit — it is essential to holistic development.

* [EXPLANATORY NOTE] We recognize Nature as an essential part of the human experience and a source of wisdom; therefore, we have chosen to write it with a capital "N."

Yet Nature can no longer be viewed in isolation. This work must be grounded in knowledge systems, values, and technologies that recognize life as deeply interconnected with the environment and with other beings, and teaching and learning as a continuous process that integrates body, knowledge, and culture. Bridging different knowledge systems — Western and ancestral — can advance a more holistic science, one that acknowledges the inseparability of culture and Nature, and values the contributions of Indigenous and Black peoples to ecosystem restoration.

This publication supports the urgent task of helping schools adapt* to climate change in their local contexts, recognizing school infrastructure as a cornerstone of quality education. Drawing on the concept of Nature-based Education (NbE) — which emphasizes learning beyond classroom walls while fostering critical environmental awareness— the guide offers a repertoire of Nature-based Solutions (NbS) tailored to the needs, realities, and bioclimatic conditions of each school. It is intended especially for school management teams as well as municipal and state educa-

* [EXPLANATORY NOTE] Climate action is commonly understood in three main areas: (i) mitigation, (ii) adaptation to the impacts of climate change, and (iii) addressing loss and damage. This guide focuses on supporting schools in adapting to the impacts of climate change.

tion and public works officials responsible for infrastructure and pedagogical planning.

Originally published in Portuguese, with a focus on effective practices and experiences from Brazil, this English edition aims to broaden the dialogue by incorporating references from initiatives around the world. Beyond sharing solutions, our goal is to highlight the urgency of advancing a global movement for Nature-based Education — one in which schools adopt practices that make them more resilient, greener, and healthier. It is also about recognizing that we are part of a biodiverse and culturally rich planetary community, united in the effort to transform schools into spaces that care for both people and the environment.

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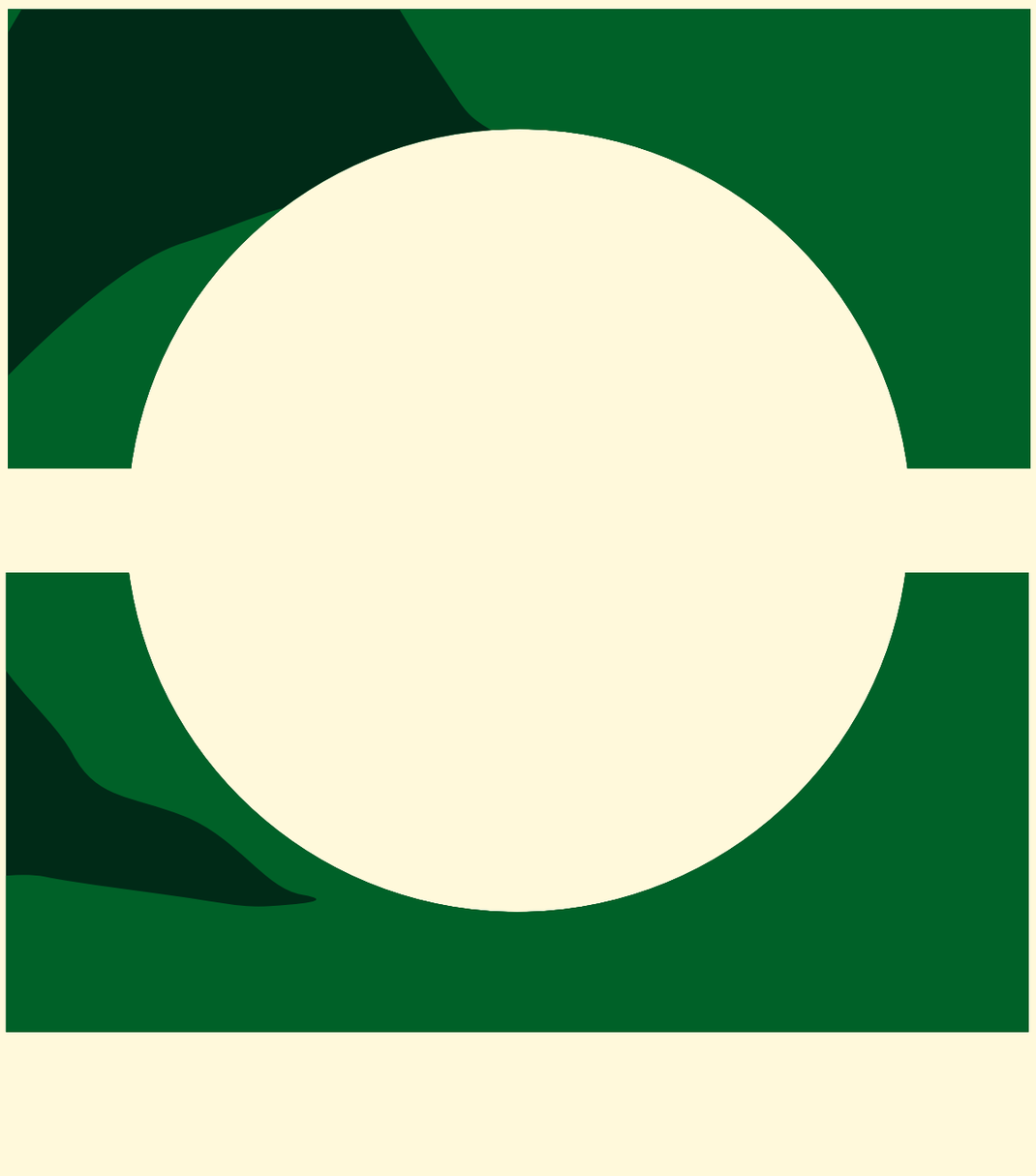
Image: Renata Ursaia / Collection: Instituto Alana

↑ Nature-based schoolyards enhance teaching and learning, support the health and well-being of the school community, and strengthen resilience to climate change.

1. Socio-environmental crises and children's rights



FREIRE, José Joaquim. [Ayenia], n.d. Drawing, watercolor, 26.5 × 17 cm.

We are living through a decisive moment, a threat to the very existence of humanity, as researchers and multilateral organizations have warned. In a 2021 report, the United Nations (UN) identified **three interconnected socio-environmental crises: climate change, biodiversity loss, and pollution.**[1] **These crises place the health and well-being of present and future generations at risk**, while at the same time causing suffering and enormous lost opportunities for all forms of life.

According to UNICEF's Children's Climate Risk Index (2021), more than two billion children worldwide are exposed to more than one climate and environmental risk. The World Bank reports that, over the past 20 years, more than five million students lost school days due to closures caused by extreme climate events.[2] Air pollution, food insecurity, lack of safe drinking water, forced migration, epidemics, droughts, floods, and heat waves **affect children disproportionately and more severely**, precisely because they are still in a vulnerable stage of development. The data are even more alarming for those facing racial, socioeconomic, and environmental disadvantages — including Indigenous and Black children, those from rural or marginalized urban communities, children with disabilities, girls, and children

from Traditional Communities* —[3] particularly in the Global South.[4]

There is also a fourth crisis, less visible but no less serious: **the crisis of disconnection from nature.**[5] In many urban areas, children are increasingly confined indoors, with shrinking opportunities to access the natural world. This is driven by multiple factors, including public safety concerns, excessive screen time, social inequality, limited access to green areas, and urban planning that pays little attention to children's needs — putting the very future of life on Earth at risk.

Life is established through connection. Nothing exists in isolation; everything is interrelated, and recognizing this web of relationships among all beings is key to sustainability. Science affirms this fact, which also underpins the ways of life and knowledge systems of Indigenous Peoples, *quilombolas*, and other Traditional Communities living in harmony with the environment.

* [EXPLANATORY NOTE] *Povos e Comunidades Tradicionais* (Traditional Peoples and Communities) is a broad legal and cultural category that includes Indigenous Peoples, *quilombolas* (Afro-Brazilian communities founded by formerly enslaved people), *ribeirinhos* (communities living along rivers — especially in the Amazon — whose livelihoods depend on fishing, small-scale farming, and river transport), extractivist groups (communities whose livelihoods depend on the harvesting of forest and natural resources, such as rubber tappers and nut gatherers), and others whose ways of life are deeply tied to the land and to the sustainable use of natural resources.

By contrast, a utilitarian and human-centered view of nature, rooted in colonial thought, shapes social organization and guides urban and rural planning. In these models, priority is given to the flow of goods and commerce, along with those who produce them. Children, rarely prioritized, are pushed out of their natural place of belonging: open, outdoor spaces. Confined between walls and fences — without green, without blue, without water, without earth, without plants, without animals, without wind or sunlight — they suffer.

The American Academy of Pediatrics affirms that being separated from nature harms children's health and development, leading to higher rates of sedentary behavior, obesity, early-onset myopia, reduced motor skills, and sleep problems.[6] At the same time, research demonstrates that contact with nature supports children's overall growth, benefiting their physical, cognitive, social, emotional, and even spiritual well-being. **For this reason, strengthening children's connection with nature is a fundamental premise for protecting their rights.** A healthy environment is vital for comprehensive development, just as a close bond with nature is key to nurturing pro-conservation attitudes throughout life.

Bringing nature into school spaces thus offers a double benefit: it supports students' comprehensive development while also making schools more resilient to climate change.

Image: Tibico Brasil / Collection: Instituto Alana

↑ The crisis of disconnection from nature —
also known as “nature-deficit disorder” — has impacts
on the health of both children and the planet.

Impacts of the climate crisis on education

The climate crisis is a global reality, and we are feeling its effects with increasing intensity.[7] News reports frequently show schools being closed due to extreme heat, floods, or landslides. These cases make clear that climate change threatens the right to education and underscore the need for schools to prepare for this new reality.

The World Bank's report on the impact of climate change on education presents alarming data: **99% of children worldwide are exposed to at least one climate event or environmental threat.** The report estimates that each year approximately 75 million children have their education disrupted by the impacts of natural disasters and conflicts, a number expected to grow with the climate crisis. A 2025 report by the United Nations Children's Fund (UNICEF) notes that **at least 1 in 7 students (242 million) across 85 countries had their education disrupted in 2024 due to extreme weather events such as heat waves, tropical cyclones, storms, floods, and droughts.**[8] In 2017, torrential rains in Southeast Asia flooded more than 12,000 schools in India, 4,000 in Bangladesh, and 2,000 in Nepal.[9]

According to the same UNICEF report, **in 2024 heat waves interrupted classes for approximately 171 million children worldwide**. In April of that year, every school in Bangladesh, Cambodia, and the Philippines was closed, affecting 63 million students. In Brazil in February 2025, schools in Rio Grande do Sul delayed reopening, affecting roughly 700,000 students, as temperatures exceeded 40 °C, making travel difficult and classrooms unsafe for teaching and learning.[10]

Another example, also in Brazil, occurred in Rio de Janeiro during the same period, when the city reached Heat Level 4,* with a heat index of up to 60 °C, according to the National Institute of Meteorology (INMET).[11] Schools were advised to avoid outdoor activities, and the state government authorized public schools without air conditioning to reduce in-person hours by 50%.

Extreme heat has significant impacts on students' health, education, and development, compromising their cognitive capacity and well-being. Studies indicate that at temperatures above 38 °C, essential functions such as reasoning, memory, and comprehension are severely impaired, while temperatures above 42 °C can cause irreversible damage, including the death of neurons.[12] In addition, the body goes on

* [EXPLANATORY NOTE] Heat Level 4, as designated by the City of Rio de Janeiro's Municipal Health Department, applies when temperatures range from 40 °C to 44 °C and are expected to persist for at least three consecutive days.

Image: Rafa Neddermeyer / Collection: Agência Brasil

↑ **Damage caused by flooding at a municipal school in central Eldorado do Sul, southern Brazil.**

high alert, diverting energy away from concentration to relieve discomfort, making it difficult to engage in school activities. Children are especially vulnerable to dehydration, experiencing dizziness, fatigue, and even fainting, along with increased irritability and difficulty socializing. The problem also affects teachers, impacting their health, cognitive performance, and classroom management when students are unmotivated and suffering from extreme heat.

A study analyzing 30,000 Brazilian schools revealed that exposure to heat increases dropout rates,

Image: Rinaldo Martinucci / Collection: Instituto Alana

↑ Many Brazilian schools are surrounded by walls and fences, without green areas or outdoor courtyards.

particularly in urban areas.[13] In India, a study of 335 primary schools highlighted students' vulnerabilities to heat exposure, showing links to absenteeism and a wide range of health impacts, including strokes, heat exhaustion, dehydration, fainting, vomiting and diarrhea, allergies, and other complications.[14]

These cases also need to be viewed through the lens of socio-environmental inequality. Climate change and extreme events affect schools differently depend-

ing on the location and the makeup of the school community. The unequal burden on certain populations, shaped by race and social factors, has been described as environmental racism.

A study carried out by Instituto Alana in partnership with MapBiomas analyzed a sample of 20,635 public and private early childhood and primary schools in all Brazilian state capitals and revealed that more than **one-third did not have green areas** on their grounds.[15] The absence of nature was even higher in early childhood education, where this percentage rose to 43.5%. The data show that **the poorer and Blacker* a school is, the less nature it has** — both within its walls and in the surrounding area — **and the more vulnerable it will be to disasters linked to the climate crisis.**

Another finding is that half of the schools located in favelas and urban low income communities in Brazil have no green areas on their grounds, and 89.6% are in areas vulnerable to climate impacts.** A racial dimension is also evident, regarding extreme heat exposure: 36.4% of predominantly Black schools record

[EXPLANATORY NOTES]

* Predominantly Black schools are those in which 60% or more of the students self-identify as Black.

** These schools are in areas vulnerable to hydrometeorological and climatic events that may trigger flooding, flash floods, or landslides.

temperatures 3.6 °C above their city's average, compared to 16.5% of predominantly white schools.

These findings reveal that schools have provided children and adolescents limited — and unevenly distributed — access to nature. This situation is troubling not only because school is the only opportunity for many children to experience nature in their daily lives, but also because schools without green spaces may feel the impacts of the climate crisis more severely.

2. Schools as spaces of climate resilience and access to nature

CODINA, Joaquim José. [Aegiphila], n.d. Drawing, watercolor, 31.5 × 18 cm.

Schools are essential institutions for promoting the right to education, safety, health, and well-being for students, families, and educators, especially during climate-related disasters. Schools with **larger green areas**[16] and those that adopt **Nature-based Solutions (NbS)**[17] are **better equipped to face the climate emergency**. Beyond vegetation alone, NbS offer wide-ranging benefits for school infrastructure and environments, as discussed in Chapter 4 of this guide. By integrating natural elements into school spaces, **these solutions strengthen climate resilience**, advance environmental and climate education, and foster deeper connections between students and nature.

In this context, experts around the world are expanding approaches to environmental education and integrating existing education strategies within an inclusive framework known as **Nature-based Education (NbE)**.[18] The International Union for Conservation of Nature (IUCN) Commission on Education and Communication defines NbE as a set of practices that weave together **ancestral and scientific knowledge**, emphasizing environmental and climate education, disaster risk reduction, sustainability, outdoor learning, and experiential learning, among other dimensions.

Rather than a one-size-fits-all model, NbE functions as an educational ecosystem that brings **nature to the center of both teaching and school design.**

It weaves together complementary strategies rooted in the local context and aligned with neighborhood- and city-level urban policies.

This approach expands opportunities to **play, learn, and build positive relationships with nature**, while also supporting holistic development. In addition to enriching pedagogical opportunities, NbE plays a strategic role in **helping schools adapt to global crises.** Through participatory, multisectoral, and inclusive practices, it builds the resiliency of school infrastructure, preparing it to withstand increasingly intense climate challenges.

To inspire and guide efforts toward climate resilience in human development, a set of guiding principles was introduced at COP29, in Baku, Azerbaijan. Principle 4 emphasizes strengthening the climate resilience of education systems, including schools and other learning environments, by recommending strategic investments that make education infrastructure safer and more adaptive. The principle prioritizes protecting the most vulnerable from climate impacts that could disrupt essential services.[19]

Moreover, a greener school with appropriate infrastructure guarantees children **the right to access nature and a healthy environment.** For many students, school is the main place where they can experience outdoor play, socialization, and learning — opportuni-

Image: Rinaldo Martinucci / Collection: Instituto Alana

↑ Ágora School in São Paulo, Brazil, promotes outdoor pedagogical practices, combining play with connection to nature and fostering the well-being of the school community in ways adapted to the local context.

ties often unavailable elsewhere in their daily lives. Rethinking school infrastructure to make it greener and more resilient is essential to delivering high-quality education aligned with today's global challenges.

In the United States, the American Society of Landscape Architects (ASLA) supports the Living Schoolyards Act (S.1538), introduced in 2023.[20] This legislation

provides funding to transform and redesign schoolyards with more natural features, replacing paved surfaces with trees and vegetation, natural stormwater management systems, outdoor classrooms, and parks. These transformations are designed to give children opportunities to experience nature while they learn.[21]

The benefits of a greener school go beyond the schoolyard and extend into the city. Schools are numerous, widely distributed public facilities and serve as important spaces for culture and community life. When schools and their surroundings become greener, they provide environmental benefits (flood prevention, temperature regulation, pollution reduction, and more) that serve not only children, families, and educators, but also the city as a whole. **Greener schools strengthen and expand the network of urban green spaces, improve access to and connection with nature**, and promote community health and well-being.

One strategy for adapting schools to climate change is the greening of school spaces through the implementation of NbS and other approaches. Green schools draw on methods that combine scientific and ancestral knowledge* to promote biodiversity

* [EXPLANATORY NOTE] In this guide, we have chosen to refer to the body of knowledge of Indigenous and Black peoples — both past and present — was ancestral sciences or systems of knowledge. By contrast, we refer to the dominant modern and contemporary systems of knowledge as Western science.

and generate shade, ventilation, natural lighting, and thermal comfort, while replacing paved areas with permeable surfaces and natural flooring. Integrating nature also involves rethinking the materials used for furniture and play-learning equipment, as well as the intended purposes of each space.

This shift is crucial for making schools healthier, safer, more resilient, and better suited to children's education and holistic development. Prioritizing nature's wisdom — grounded in Nature-based Solutions (NbS) and ancestral knowledge — is prompting many countries to pursue innovative approaches to transform educational infrastructure, preparing schools to face current and future climate challenges and to safeguard the right to education.

Image: Joel Reichert / Collection: Instituto Alana

↑ Children painting in an outdoor space at Aldo Pohlmann Municipal School of Early Childhood Education in Novo Hamburgo, Brazil.

Benefits of greener, more resilient schools

Thermal comfort: protection against extreme heat and pollution

- Children are more vulnerable to intense heat. Vegetation provides natural shade, lowering the microclimate temperature and improving thermal comfort both inside and outside classrooms.
- The evapotranspiration* of plants and reflecting pools increases humidity, making the environment cooler and more pleasant.
- Vegetation filters air pollutants, improves air quality, and creates a healthier environment for the school community and its surroundings.
- Tall trees and denser vegetation act as natural barriers against noise, reducing sound pollution and providing greater acoustic comfort for the school community.

* [EXPLANATORY NOTE] Evapotranspiration is the process by which water moves from soil and plants into the atmosphere as vapor, combining evaporation (water loss from soil and surface water) and transpiration (water released by plants). It is a key part of the hydrological cycle, shaping climate, water availability, and agriculture.

- The creation of water features, such as reflecting pools, provides thermal comfort as well as places where children can cool off, play, and learn from this natural element.
- Adaptations to school facilities that allow cross-ventilation and natural light increase air circulation, improve thermal comfort, and reduce the energy needed for cooling and artificial lighting.
- Green roofs and façades create more energy-efficient areas and promote carbon capture, while also reducing the sensation of heat in indoor spaces.

Reducing the impact of floods and droughts

- Environments that support rainwater management, such as those with larger permeable areas, improve soil drainage and slow water runoff after heavy rains, reducing the risk of flooding.
- Schools with more vegetation help retain rainwater, keeping the soil moister and easing the effects of drought periods.
- Schools that invest in rainwater harvesting and storage help reduce the use of water from external and nonrenewable sources, are better able to withstand periods of drought and dry spells, and are less dependent on outside supply.

Biodiversity regeneration and strengthening of local ecosystems

- Green areas in schools create habitats for pollinators, birds, and small animals, helping restore degraded urban ecosystems and contributing to increased biodiversity.
- Schools can serve as teaching spaces for observing, learning about, and valuing local biodiversity, while promoting restoration and planting projects such as mini-forests, edible gardens, vegetable plots, etc.
- Green areas within schools can support the creation of urban ecological corridors, increasing the number of connected forest fragments.
- Native plants and fruit trees incorporated into school landscaping can contribute to the recovery of local flora and offer nutritional and educational benefits for children.

Improving the teaching and learning environment and promoting health and well-being

- Greener classrooms and schoolyards with milder temperatures support the physical and mental health and well-being of students, teachers, and other education professionals, making it easier to concentrate and perform academically while also encouraging physical activity.
- Cool, shaded environments ensure access to recess, encourage play, social interaction, and outdoor learning, and contribute to children's holistic development.
- Strengthening the connection between students, the community, and nature promotes environmental and climate education, increases appreciation of ancestral knowledge, and takes learning beyond walls for the whole school community.

Benefits for the community and the city

- Green schools can become quality public spaces for residents on weekends and during periods of extreme heat, democratizing access to climate shelters for neighborhood communities.

- Expanding green areas and vegetation in cities contributes to climate resilience, increased biodiversity, and improved quality of life in urban centers.
- Choosing natural and locally sourced materials can reduce the impact on the planet's limited resources and encourage their sustainable use.

Opportunities for quality climate education

- Observing natural phenomena within the school environment sparks curiosity, investigation, and deeper understanding of core science concepts.
- Students explore the impacts of climate change through direct outdoor experiences, including play, exploration, and social interaction.
- Hands-on projects, grounded in research and inquiry, can generate solutions and bring positive changes to school spaces, while also building knowledge and attitudes that last a lifetime.
- Understanding the use and functioning of NbS is a key skill for addressing environmental challenges and confronting the climate crisis.
- An interdisciplinary approach integrates different fields of knowledge through research, investiga-

tion of natural phenomena, and participatory design and implementation of NbS.

- The processes of diagnosing, creating, and caring for NbS can provide opportunities to foster children's leadership.
- Creating and using NbS can foster participation by the school community and partners, while providing opportunities to value ancestral knowledge and engage local resources.

Image: Gwendoline Grandin

↑ **At Archimbaud School in France, the schoolyard features spaces and furnishings for multiple uses, including NbS that enhance water management, thermal comfort, local biodiversity, and opportunities for outdoor learning.**

> A study of 526 students aged 10–11 in 37 Belgian schools found that green playgrounds designed as Nature-based Solutions (NbS) increase children's contact with nature. These spaces help make up for the lack of urban green areas and have positive effects on attention, learning, and well-being, with benefits that extend beyond the school grounds.[22]

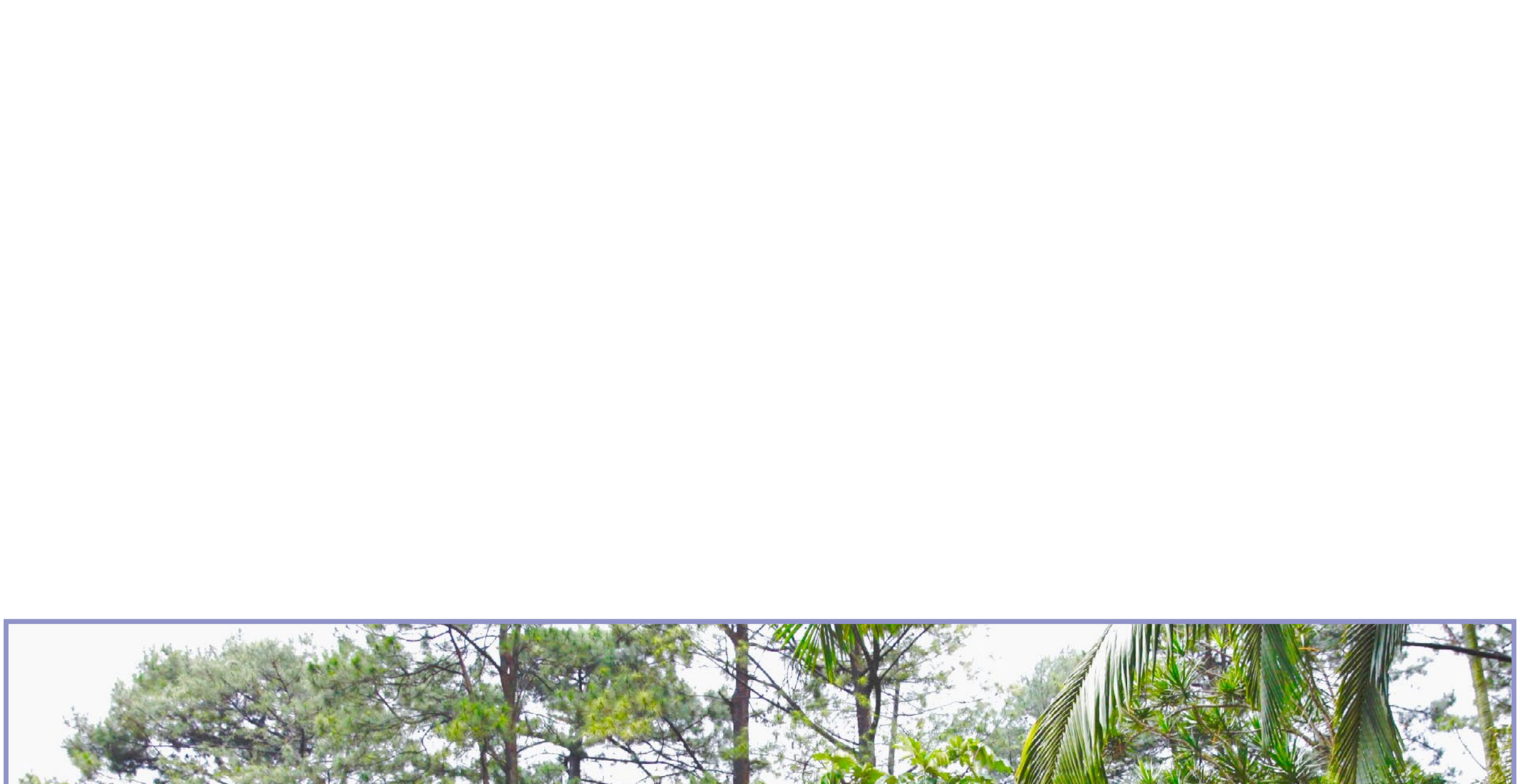


Image: Rinaldo Martinucci / Collection: Instituto Alana

↑ At Ágora School in São Paulo, Brazil, an open classroom integrated with a tree-filled outdoor space offers an alternative that provides thermal comfort and well-being.

EFFECTIVE PRACTICES

School initiatives as climate refuges

Worldwide, there are many efforts to bring more nature into schools, recognizing its benefits for children's development and for adapting to climate change. Standout examples include:

- **Centro Educacional (CED) Agrourbano Ipê, Brazil**[23]
  Since 2010, CED Agrourbano Ipê, in Riacho Fundo II, Federal District, has integrated environmental education into its pedagogical framework, developing NbS as low-cost sustainable technologies in partnership with students. Initiatives include rainwater harvesting, a wastewater treatment station, an ecological classroom, and stingless beekeeping. Teachers guide and share activities with the community, amplifying both educational and environmental impact.

- **Escola Parque – Cleide Rosa Auricchio Municipal School of Early Childhood Education, Brazil**[24]
  Built in the center of a public square in São Caetano do Sul in São Paulo, the Cleide Rosa Auricchio Municipal Early Childhood Education School embraces the Escola Parque (Park School) concept, bringing together community, nature, and childhood. Its landscaping highlights the Atlantic Forest with sensory gardens, a vegetable garden, an orchard, and trails that invite both aesthetic and environmental experiences. With spaces designed for outdoor play and learning, the school nurtures a sense of belonging, environmental stewardship, and meaningful experiences.

+ EFFECTIVE PRACTICES

- **TiNis – Tierra de los Niños, Peru**[25]
  This is an initiative of the Asociación para la Niñez y su Ambiente (ANIA) (Association for Children and Their Environment), aimed at connecting children and young people with Mother Earth so that they may become agents of change for sustainable development. The program seeks to increase natural, biodiverse spaces by planting and caring for gardens and other outdoor areas that provide multiple benefits — places where young people feel welcomed and safe, and where they can learn and play. The pilot project achieved impressive results, and the methodology was later shared with neighboring countries — Brazil, Bolivia, and Ecuador — where it also has had positive impacts.

Image: Francisco Atanásio / Collection: Instituto Alana

↑ Municipal school in Benevides, Brazil, implemented the TiNis methodology in partnership with the school community to transform outdoor spaces through planting and play activities.

+ EFFECTIVE PRACTICES

- **Case Study: Cristóbal Colón School, Colombia**[26]
  The Escolas para Resiliência (Schools for Resilience) project, in Cali, proposes a new model of school infrastructure that strengthens climate and socio-environmental resilience. Based on a pilot at Cristóbal Colón School, which is located in a vulnerable urban area, principles were defined for safer schools that are better integrated with their communities. The strategies include connecting with urban parks, using green infrastructure, managing water and energy efficiently, creating outdoor learning spaces, and improving thermal comfort.

- **Fundación Patio Vivo, Chile**[27]
  The foundation transforms schoolyards into Paisagens de Aprendizagem (Learning Landscapes), recognizing outdoor space as a classroom. In partnership with public and private schools, it designs greener, more diverse, and more inclusive schoolyards that promote free play, connection with nature, and holistic development. Each intervention is grounded in listening to the community and valuing local knowledge, combining NbS, active pedagogy, and school culture. These “living schoolyards” strengthen belonging, creativity, and social interaction, while contributing to climate adaptation in cities, starting with schools.

Image: Alvaro Benitez / Collection: Fundación Patio Vivo

↑ The schoolyard at Chilean Eagles College, in Chile, offers varied stimuli and spatial configurations, incorporating topography, landscaping, open areas, and a wide range of unstructured play materials to foster imagination and exploration.

+ EFFECTIVE PRACTICES

- **Climate Refuges, Barcelona, Spain**[28]
  This public policy in Barcelona aims to transform 80 schools, currently considered vulnerable to high temperatures, into climate shelters open to all city residents. The program introduces heat-mitigation measures in school buildings and transforms schoolyards with vegetation, shaded areas, and water features. Beyond schoolyards, the school's urban surroundings are also adapted, extending the program's positive impact to public spaces. Pedestrians are prioritized with dedicated walking areas featuring playful elements to engage children, benches for rest, tree planting for thermal regulation, and water management strategies.

Image: Jaume Barnada

↑ **The street in front of La Sedeta School in Barcelona features NbS, trees, a safe area for pedestrians, playful ground elements, and benches for rest.**

+ EFFECTIVE PRACTICES

- **National Schoolyard Forest System, United States**[29]
  This is a public policy initiative that establishes forests on public school grounds to help protect students from extreme heat linked to climate change.

- **International School Grounds Alliance (ISGA)**[30]
  The ISGA is a global network of voluntary, nonprofit organizations working to enrich children's learning and play by greening schoolyards. The organization recognizes that schoolyards, situated at the heart of their communities, play a vital role in addressing the impacts of climate change and advancing climate justice for children and adolescents.

- **Green Community Schoolyards, United States**[31]
  This program aims to transform school spaces into green, safe, and accessible places for communities — especially in vulnerable neighborhoods — where residents can gather close to home and connect with nature. Green schoolyards are also essential for climate resilience, helping to mitigate increasingly extreme heat and flooding that affect New York City.

- **Climate Park – Sint-Paulus School, Kortrijk, Belgium**[32]
  With support from the Flemish Department of Environment, the school transformed 4,000 m^2 of schoolyard and parking lot into a climate park that combines green and paved areas. Roughly 90% of the roofs were connected to a rainwater harvesting system, promoting infiltration, reuse, and recharge of the groundwater table. Native vegetation provides shade, reduces heat stress, and improves air quality. The project engaged students, teachers, families, and experts, creating an outdoor learning environment with a vegetable garden and beehives. The school also became a community gathering place and a hub for ongoing environmental education.

Image: Cedric Ryckaert

BEFORE

AFTER

↑ **At Sint-Paulus School in Belgium, the schoolyard transformation included adding water features and various natural elements, enhancing biodiversity, the local landscape, and the use of outdoor space as a place for play and learning.**

3. School infrastructure and quality of education

UNKNOWN ARTIST. [Arrhostoxylon], n.d.
Drawing, watercolor, 26.5 × 17 cm.

School infrastructure is an important indicator of educational quality.

> **Beyond safety, thermal comfort, sanitation, and health standards, the way spaces are designed and organized helps shape learning environments, supports teaching, and provides a foundation for curriculum development.**

Infrastructure also includes buildings, equipment, and teaching materials — resources that directly influence children's autonomy and active participation in their own learning.[33]

Moreover, **school infrastructure promotes health, well-being, and holistic development.** In many contexts, especially those marked by inequality, school may be the only place where children can run, play outdoors, enjoy the sun, and move freely.

In this way, physical space becomes part of the curriculum and the educational approach, expanding teaching methods beyond the classroom. With this in mind, we highlight below a set of international initiatives that support the right to nature-based school infrastructure.

Image: Felipe Correia / Collection: Instituto Alana

↑ Children at Tia Lourdinha Municipal School in the city of Caruaru, Brazil, climb a greened playground structure in the schoolyard. Greened spaces encourage free play and support children's holistic development.

Public policies and programs for resilience and adaptation

International programs

There is a growing international movement in favor of green infrastructure in schools, driven both by the need to adapt to climate change and by the promotion of education that fosters climate literacy — supporting risk and disaster prevention and the building of a more sustainable society. This movement aligns with global initiatives such as the 2030 Agenda for Sustainable Development, which includes the Sustainable Development Goals (SDGs).

UNESCO Greening Education Partnership (GEP)[34]

This global initiative takes a systemic approach to supporting countries in addressing the climate crisis, with education playing a central role. Drawing on the holistic approach of Education for Sustainable Development (ESD), the Greening Education Partnership seeks to inspire countries to empower learners with the skills needed for inclusive and sustainable eco-

nomic development in the transition toward digital and green economies. The partnership is structured around four key pillars of transformative education: i) Greening schools, ii) Greening every curriculum, iii) Greening teacher training and education system capacities, and iv) Greening communities.

Sendai Framework for Disaster Risk Reduction 2015–2030

Adopted at the Third UN World Conference on Disaster Risk Reduction, this **global commitment** guides the integration of risk management into education policies, promoting **resilient schools and safe infrastructure**. It calls for investments in prevention, adaptation, and governance to ensure sustainable buildings and the continuity of learning in the context of climate-related disasters.

The Global Alliance for Disaster Risk Reduction and Resilience in the Education Sector (GADRRRES) serves as a platform to translate the principles of the Sendai Framework into the reality of schools. Among its strategies is the Comprehensive School Safety Framework (CSSF).

Image: Rinaldo Martinucci / Collection: Instituto Alana

↑ School resiliency depends on safe surroundings and disaster risk prevention. Children play in a circle on the outskirts of Carapicuíba, São Paulo, Brazil.

Nature-based Education for Planetary Health – International Union for Conservation of Nature (IUCN)[35]

Led by the International Union for Conservation of Nature's Commission on Education and Communication, this initiative brings together global experts to reimagine environmental education and existing educational approaches. Nature-based Education (NbE) is an ecosystem of blended strategies that include environmental education, Indigenous ways of knowing, climate and biodiversity education, education for

sustainable development, outdoor and experiential learning, mindfulness, and socio-emotional learning, among others. Building on the commission's earlier work on Education for Conservation (EfC), NbE is not a one-size-fits-all model. Instead, it serves as an educational ecosystem that integrates diverse and complementary initiatives, placing nature at the heart of learning.

Climate Smart Education Systems Initiative[36]

The Global Partnership for Education (GPE) leads this initiative to accelerate access, improve learning outcomes, and advance gender equality by building equitable, inclusive, and resilient education systems for the 21st century. The initiative aims to make all education systems "climate smart" by providing grants, technical assistance, and fostering partnerships that connect education and climate finance through the Building the Climate Resilience of Children and Communities through the Education Sector (BRACE) fund. Its goal is to ensure that even the most vulnerable children can continue learning in the face of climate disasters such as droughts, floods, and heat waves. In addition to supporting countries in developing resilient education systems, GPE promotes climate

change education and disaster risk awareness. The partnership also helps countries strengthen capacity and use data to create contingency plans and targeted strategies, ensuring that learning continues during environmental crises.

Image: Maria Isabel Amando de Barros

↑ **At Maryse Hilsz Elementary School in Paris, France, the courtyard areas were greened through expansion to create a variety of distinct spaces with paths, balance beams, games, and planted mounds, enhancing the sense of dense vegetation.**

National programs

Philippines

The Philippines is among the most disaster-prone countries in the world. According to the INFORM Risk Index and the Global Risks Report 2024, the country consistently ranks among the ten most at risk. In basic education alone, 98% of students — about 28 million children — are exposed to multiple hazards. The government has prioritized educational resilience through policies and legislative measures. A key milestone was the enactment of the Children in Emergencies (CiE) Law in 2016, which institutionalized support systems for children before, during, and after emergencies.[37] The law establishes risk-based school planning, psychosocial support, and accountability mechanisms, forming the legal backbone for school safety programs nationwide.

To adapt to climate impacts, in 2023 the Department of Education issued Order No. 019, s. 2023, *Institutionalization and Implementation of Risk-Informed and Evidence-Based School Infrastructure Planning and Programming*.[38] This policy seeks to invest in school infrastructure that is green, safe, resilient, inclusive, and conducive to learning, significantly reducing impacts through risk management, evidence-based policies, plans, and programs.

India

The Green Schools Program promotes a whole-school approach to education, combining environmental learning, hands-on activities that raise student awareness, and the efficient use of available resources.[39] To qualify for the program, schools must meet criteria such as maintaining green coverage on school grounds, collecting and reusing rainwater, and composting organic waste.

In 2025, 356 schools were recognized during the Green Schools Festival, part of the broader program. Eleven categories of sustainability were monitored, in a context where 48% of schools in the country currently have at least 35% green coverage on their grounds, 25% have rainwater harvesting systems, and 30% separate waste and compost organic matter, among other sustainable practices.[40]

Municipal program

London, United Kingdom
Climate Resilient Schools Program

The City of London, in coordination with the Department for Education and the company Thames Water,

launched a program to make 100 schools more resilient to climate impacts.[41] Priority was given to schools located in areas most vulnerable to flooding.

The program's first strategy was the creation of 564 rain gardens to reduce flood risk by capturing water from rooftops. These gardens also provide habitats for biodiversity and improve well-being for the community. Weather stations were installed in 24 schools, along with rainwater collectors in 30 rain gardens, to monitor their effectiveness. Each station includes educational signage, allowing the space to be used for outdoor lessons.

In addition, climate adaptation plans were developed for 60 schools to identify the most effective measures for reducing their specific risks. These included installing green roofs and adding shading to windows to lower heat levels.

The plans were based on a 2020 report that recommends a range of Nature-based Solutions (NbS), such as rain planters, rain gardens, tree planting, shade structures, filter drains, permeable hard surfaces, green surfaces (such as lawns that reduce heat), ponds, bioswales, and stormwater retention basins, among others, with options that can be integrated into existing built spaces.[42]

Image: Ligia Lanna / Collection: Instituto Alana

BEFORE

Image: Marcella Rodrigues e Patrícia Silva / Collection: Instituto Alana

AFTER

↑ The transformation of a schoolyard in Caruaru, Pernambuco, Brazil, increased soil permeability, added trees, and incorporated play equipment and natural elements, helping to lower ambient temperatures and promote free, active play. The schoolyard adaptation resulted from a partnership between Instituto Alana and the van Leer Foundation in a municipality that belongs to the Urban95 Network.

EFFECTIVE PRACTICES

Centro Nacional de Monitoramento e Alertas de Desastres Naturais (Cemaden)

In Brazil, Disaster Risk Reduction Education (ERRD) is carried out through Cemaden Educação (Cemaden Education), a program linked to the Ministry of Science, Technology, and Innovation (MCTI).[43] The program engages schools, young people, and communities in building a culture of disaster risk awareness and prevention. It promotes educational journeys where scientific knowledge is combined with community wisdom and curriculum integration proposals, using a citizen science approach. Below is an example of this work:

Education saves lives in Jaboatão dos Guararapes, Pernambuco, Brazil [44]

- In May 2022, heavy rains caused 64 deaths in Jaboatão dos Guararapes. Yet in the community of Retiro, no lives were lost. The difference? **Education and community preparedness.**

  Through a joint effort between Cemaden Educação and the Community Center for Civil Protection and Defense (Nupdec), students were trained in climate change and disaster risk. When intense rains struck, they put their knowledge into action, mobilizing residents and ensuring the safe evacuation of high-risk areas. The result: **lives saved through education.**

4. Nature-based school infrastructure: practical guidelines

CODINA, Joaquim José. [Anguria, Sp.], 1788.
Drawing, watercolor, 26.5 × 17 cm.

Adapting schools to climate change requires taking into account the diversity of biomes, ecosystems, climates, hydrology, and landscapes — in short, the ecological, socio-environmental, economic, and cultural conditions of the regions where they are located. The impacts of climate change affect each bioclimatic reality differently, creating unequal consequences depending on the territory and on the characteristics of students and school communities. This chapter presents a range of solutions to support greening projects in school spaces, with an emphasis on adapting and renovating existing schools.

The aim is to expand the set of proposals that can be applied across different types of school infrastructure and in various regions of the world. To that end, this chapter offers practical solutions and step-by-step guidance for greening and climate-adapting schools using **Nature-based Solutions (NbS) and other design strategies.**

NbS are approaches inspired by ancestral practices and natural processes that address environmental, social, and economic challenges.[45] Harnessing nature's capacity to regenerate and adapt, these solutions balance human needs with the preservation and restoration of ecosystems. Rather than relying solely on artificial, resource-intensive technologies, NbS draw on ancestral technologies, local elements, and the natural resources of each region to confront problems such as pollution, heat islands, resource scarcity, and biodiver-

Image: Venuza Olegário / Collection: Instituto Alana

↑ In the renovation of the courtyard at Early Childhood Education Center Maria Helena in Sobral, Brazil, priority was given to using natural elements and promoting play, with a permeable surface.

sity loss, while promoting sustainable, accessible, and effective alternatives.[46]

The International Union for Conservation of Nature (IUCN)[47] defines Nature-based Solutions (NbS) as "actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, benefiting people and nature at the same time."[48] A distinctive fea-

ture of nature-based infrastructure is its **pedagogical potential, closely tied to problem-solving**. Unlike conventional engineering, NbS provide hands-on, interactive experiences that help users understand the causes of the challenges they face and imagine solutions. These infrastructures aim to be self-explanatory, engaging, and playful, fostering a culture of care and active connection with soil, water, plants, and animals.

For these strategies to reach their full potential, they must be adapted to regional realities, respecting the cultural, climatic, and ecological specifics of each place. **Drawing on the knowledge of Indigenous Peoples and Traditional Communities enriches the solutions, incorporating ancestral wisdom that respects natural cycles and makes use of local materials and techniques**. The technologies that emerge from these knowledge systems and practices offer sustainable, culturally meaningful, and economically viable alternatives for the school environment.

In this section, we share methodological approaches and the guiding concepts behind greening school spaces, providing a foundation that can be adapted across different contexts and biomes. The content draws on Instituto Alana's experience with pilot projects for greening school spaces, recognition of ancestral practices and sciences, international exchanges, and in-depth studies on NbS and school infrastructure.

EFFECTIVE PRACTICES

Ancestral knowledge and education for well-being

NbS are not a modern innovation. **For centuries, Indigenous Peoples and Traditional Communities have lived in harmony with nature, fostering regenerative practices that preserve ecosystems and ensure well-being.** This ancestral knowledge, passed down from generation to generation, is now recognized as an essential and indispensable path for addressing global crises and building sustainable, livable futures.

At **Assentamento Terra Vista** in Bahia, Brazil, this vision is at the core of both education and daily community life.[49] **Agroecology, reforestation, and education for life in the countryside** are the pillars of this territory and of its **Florestan Fernandes School**, which for more than 30 years has been transforming local realities based on principles of nature and collectivity.

Here, education and nature are deeply intertwined. The school space is a **living territory of learning**, where students actively participate in planting, restoring streamside vegetation, and protecting headwaters. Initiatives such as the **native seedling** championship nurture a sense of belonging and foster ecological and environmental responsibility.

Image: Pedro Carranca / Collection: Instituto Alana

↑ Children participating in a community clean-up and planting at Monte Bom Jesus Park, Caruaru, Brazil.

Greening school infrastructure, step by step

① Planning and participation

1.1 Shared governance

As noted earlier, school infrastructure should always be developed in alignment with curriculum design. It is therefore essential to involve everyone who uses the space and is part of the school community in conceiving and implementing adaptive interventions: education professionals and administrative staff; children, their caregivers, and families; the student council; and the community around the school. A subset of these stakeholders can form a committee to oversee the entire process, ideally facilitated by school leadership or the education department.

A participatory, co-creative process begins with actively listening to all stakeholders, paying attention to their specific needs and using communication tools suited to each group. Some basic guidelines:

- **Establish** open, honest dialogue with the entire school community.

Clarify every stage of implementation, including when and how co-creation and participation will happen, and what is expected.

Present a draft proposal for dividing tasks and responsibilities, and remain open to change.

Create structured spaces for listening and participation.

Formalize a working group (WG) with representatives of the school community, community volunteers, and other interested actors to accompany and participate in all stages.

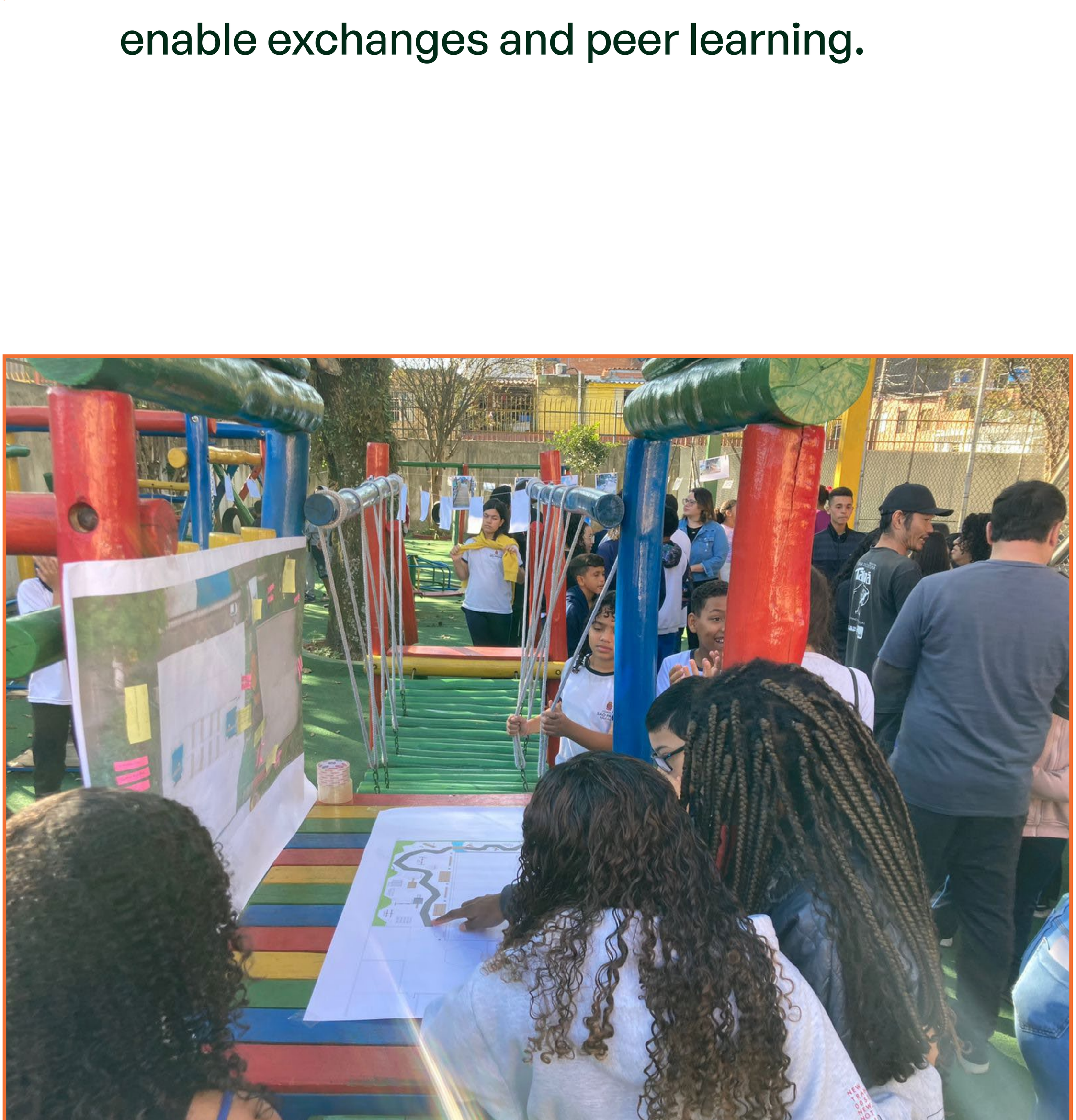
Ensure the WG has direct lines of communication with technical staff from the education department and other agencies, such as environment and public works, for technical consultations and targeted reviews.

Map qualified local service providers capable of implementing and maintaining NbS and build relationships with them.

Assess maintenance conditions for facilities and for NbS, along with the resources required to sustain them.

Identify similar experiences and practices to enable exchanges and peer learning.

Image: Ligia Lanna / Collection: Instituto Alana



↑ Children and adults taking part in awareness activities at Virgílio de Mello Franco Municipal Elementary School, São Paulo, Brazil, help build a sense of community and belonging in the school environment.

1.2 Awareness activities for greening school spaces

The engagement of stakeholders mentioned earlier can be strengthened by spreading and deepening the concept of “resilient school infrastructure” and its benefits. Sharing examples of effective practices and their impacts on the school community and the environment, inviting specialists to give talks, and encouraging participants to reflect on their surroundings are all ways to raise awareness and spark ideas for possible transformations of school environments.

Organizing discussion circles, trainings, presentations, or hands-on activities — such as visits to sites where NbS have been implemented — are valuable tools to inform, inspire, and expand knowledge. The key is to choose activities suited to each group and context.

1.3 Resource mobilization for implementation and maintenance

To be viable, school infrastructure climate adaptation projects require mobilization of financial, material, and above all, human resources. Mapping local expertise, suppliers, and regional technologies can help identify strategies for physical adaptations to school spaces while also supporting the local economy by valuing

community practices and knowledge, and by using raw materials available in each region. Strong, engaged school leadership is key to success, since it provides the foundation for sustained action and commitment.

Funding for the implementation and upkeep of school spaces can come from different sources, such as public programs dedicated to school infrastructure or through partnerships, depending on the practices of each country, region, or city.

1.4 Assessing physical spaces with the school community

It is essential to **begin with a school space assessment shaped by community voices, and only then move on to project design and implementation.** Understanding how spaces are used is key, since planned interventions will directly affect those dynamics. This stage guides all others, as it helps identify the community's challenges, strengths, and aspirations — of students, school leadership, teachers, staff, and caregivers — reinforcing collective priorities for school spaces.

Project design should be grounded in this input and focus on the interventions needed to adapt the school environment to climate change. Adaptation should address environmental issues (heat, flooding, water scarcity, landslides, among others) while supporting

pedagogical goals — for example, creating spaces for play, learning, socializing, exploration, and rest.

Children and the wider school community should be involved from the very beginning, during the initial assessment of spaces. Their participation builds integration, provides valuable insights, and fosters a sense of ownership that is essential for understanding proposals and ensuring ongoing care of the spaces.

Teacher involvement is also crucial for understanding which pedagogical practices already take place outdoors, what resources are available, and what challenges exist in introducing new activities. This helps ensure the project is grounded in the school's reality. To encourage adult participation, it can be helpful to use playful activities, create moments of enjoyment, and draw on their own childhood or school memories. At the same time, it is important to consider the broader environmental, social, and cultural context in which the school is situated.

The assessment should also consider the socio-environmental risks and vulnerabilities affecting school infrastructure. Another important aspect is recognizing the school's bioclimatic zone and other environmental characteristics, which provide key information about sun exposure, ventilation, and rainfall, and how these affect the site.

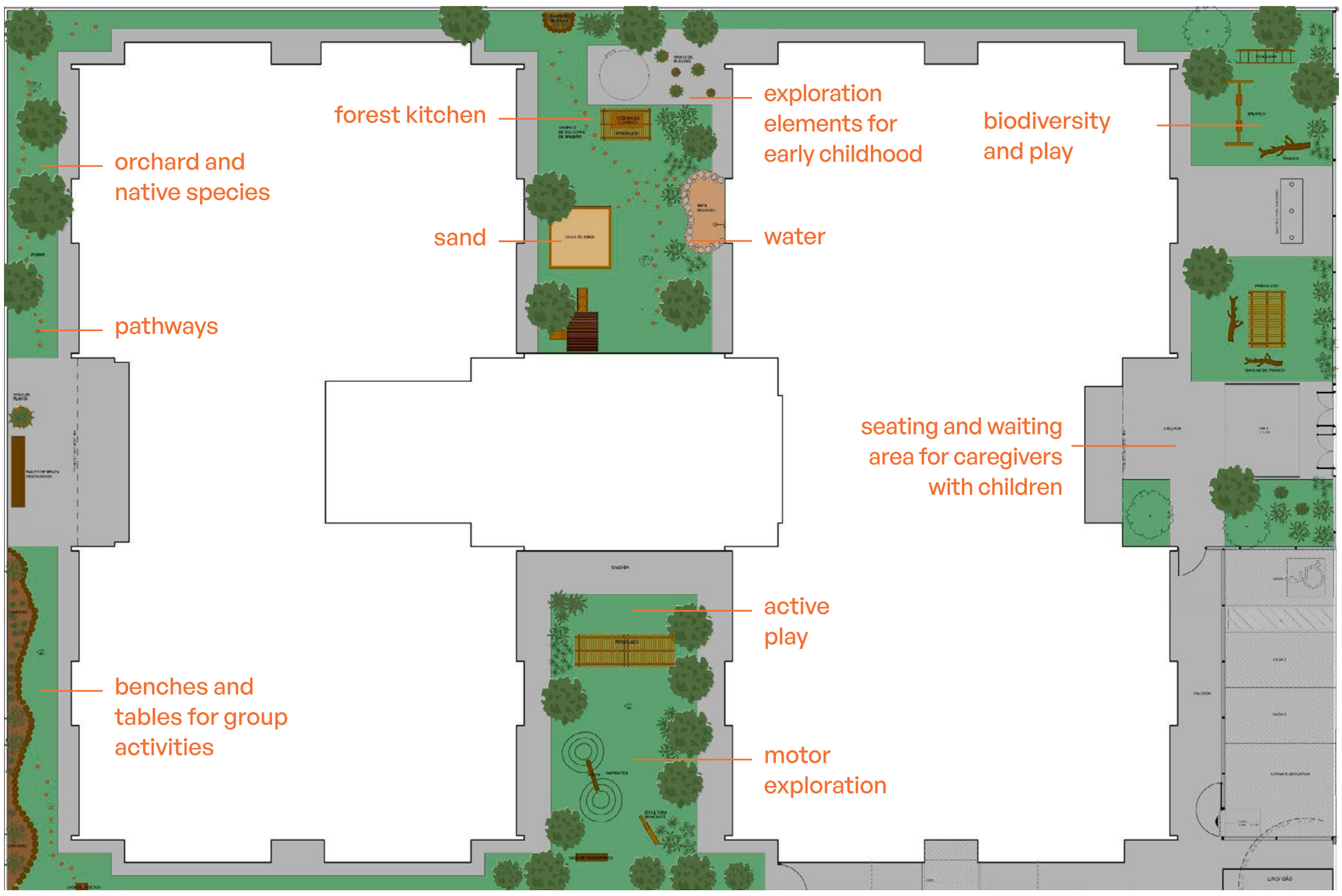
All outputs from participatory activities should be documented and organized, whether videos, audio recordings, drawings, photos, or written accounts. Drone photos, satellite images, hand sketches, and school floor plans can also support this stage.

Creating a snapshot of the school's reality before implementation results in a valuable resource for project development and, later, for evaluating the impact of interventions on teaching practices and environmental comfort. This process should also consider the needs of different age groups and how to integrate them into the spaces, including ergonomic considerations.

Guiding questions for the assessment may include:

- What outdoor spaces does the school have?
- How is each space used?
- What problems and strengths does each space present?
- Where is sunlight strongest?
- What environmental challenges affect the school and its surroundings?

Image: Image / Collection: Instituto Alana



↑ At a school in Sobral, Brazil, mapped intentions and zoning spaces by use guided the renovation of outdoor areas.

Image: João Sal / Collection: Instituto Alana

↑ Children in Jundiaí, Brazil, draw their dream space. Understanding the challenges and needs of the school community through the development of a socio-spatial assessment is essential for creating a project suited to the local reality.

② Project design

2.1 Mapping intentions for school spaces

Following the assessment stage described earlier, it becomes possible to map the school's different environments and their socio-environmental conditions. This process results in **zoning that identifies the main uses, challenges, opportunities**, as well as existing circulation patterns.

Defining clear intended uses for each outdoor school space enhances both educational and play opportunities offered by the environments. In practice, this means assigning different purposes to different areas, diversifying and expanding learning opportunities through targeted interventions. For example, some spaces may be better suited for active uses such as running, ball games, and sports. Others may foster small-group gatherings, socialization, rest, contemplation, observation, and more reflective interaction with nature. In all spaces, it is important to include areas for caregivers — places where they can observe and interact with children as well as take breaks. It is equally important to plan for circulation and connections among these different areas. The goal is to compose a landscape for play and learning, shaped by NbS, that offers a wide range of possibilities.

With this broader understanding of what school spaces can provide, the elements of the project can be selected strategically. In this chapter, they are organized into categories of intervention, based on their potential for climate adaptation and for improving the quality of the school environment.

2.2 Project concepts for adapting school infrastructure

This section presents design elements that place nature at the center of the school environment — an approach that supports the greening of spaces. The aim is to create educational landscapes that invite play and learning while also helping school infrastructure adapt to climate change. The elements include:

- **Landscaping:** Exterior design can prioritize local biodiversity and make use of topography, water, and other natural features as core components of the space. Native and endemic species are usually most suitable, since they are already adapted to local conditions. Selection should also consider functions such as water retention, nutrient absorption, pollutant filtration, soil stabilization, and long-term soil support. Community preferences also matter: Would they like food-producing plants? Trees for climbing? Medicinal plants? Species that

attract pollinators? Seeds children can play with? Landscaping also involves planning for permeable surfaces, ground cover, pathways and trails, and small hills to enrich otherwise flat terrain.

- **Play equipment and furniture:** These features encourage play, present challenges, support group work, provide resting places for caregivers, and promote social interaction.

- **Art and cultural identity:** Incorporating local art and cultural elements (wood sculptures, graphic designs, performance spaces, etc.) strengthens belonging and highlights regional culture.

- **Systems and infrastructure:** Architectural solutions, such as strategically placed openings in school buildings, connect indoor and outdoor areas, improve cross-ventilation, and increase natural light. These sustainable features improve thermal and visual comfort while reducing energy use. Solar energy systems and rainwater harvesting also make important contributions. Integrating architectural solutions with NbS strengthens both sustainability and collective well-being.

- **Nature-based Solutions (NbS):** NbS offer practical responses to environmental problems identified in each school context. They help adapt infrastructure to climate change and reduce its impact on students' daily lives.

To support climate adaptation in schools and reduce the impacts of extreme weather events, we highlight solutions suited to each region's bioclimatic characteristics. These address common challenges such as **landslides, water scarcity, extreme heat, heavy rains, and localized flooding.**

We recommend adopting **solutions at different scales and levels of complexity**, grouped into five main categories:

A. Water management

B. Thermal regulation

C. Energy efficiency

D. Furniture and landscape design

E. Slope stabilization

When combined, these solutions build resilience and strengthen schools' ability to adapt to the climate crisis. Their application should be planned according to local conditions and organized into **project designs** suited to each context.

The following section presents a set of NbS selected to address the most common problems schools face, arranged by level of complexity and assessed for implementation challenges, cost, and maintenance needs. **This list is not exhaustive; the toolkit can and should be expanded for each context. The goal is to provide general guidance for planning school space adaptation and, where possible, point to additional sources for more detailed instructions.**

Once strategies for improving school infrastructure are in place, the next step is to involve a technical team — professionals or consultants who can help turn the plan into action. Look for experts who can estimate needed materials, identify the necessary services, and guide and simplify implementation. Often, these specialists can be found within the local community or through municipal departments such as education, public works, urban planning, and environment.

- **And note:** These professionals can also work alongside teachers, creating rich learning opportunities for both educators and students.

Image: Paula Mendonça / Collection: Instituto Alana

↑ Consultant Peetssa Pdoisrca reviews students' assessments to support the selection of Nature-based Solutions at Virgílio de Mello Franco Municipal Elementary School, São Paulo, Brazil.

2.3 Choosing solutions for a resilient school infrastructure

A Water management

Today, it is essential to adopt strategies that reduce the use of potable water and encourage its reuse. Water comes from limited, non-renewable sources; therefore, protecting and restoring vegetation along rivers and streams — areas permanently set aside to safeguard water sources — is a top priority.

There are many ways schools can reduce water consumption. The first step is to install and monitor water meters. Meter readings allow schools to track monthly consumption patterns, which typically increase during hotter months and decrease during cooler months. By calculating the relationship between total monthly consumption and the number of students, schools can establish a per capita consumption benchmark. This can then be compared with other schools to determine whether water use is within an acceptable range. Water meters also record real-time consumption, making it possible to detect leaks when facilities are not in use.

Additional technical measures include installing flow restrictors (or regulators) that adjust water

flow to intended use and seasonal needs: lower for hand-washing taps and cooler months, and higher for taps in kitchens and bathrooms or during hotter, drier periods.

Rainwater management should be planned from top to bottom, aiming to retain rainwater at its source — ideally capturing it for reuse rather than letting it run into storm drains and waterways. Solutions include collecting, reusing, retaining, and treating water locally to reduce loss through conventional drainage, slow the flow of runoff, and improve both storage and redirection.

This process begins on rooftops.[50] Green roofs absorb part of the rainfall, while excess is directed through gutters and rain gardens into cisterns located on school grounds. At ground level, permeable terrain is crucial to reduce the risk of localized flooding. Schools can also implement rain gardens and “cool islands.” Together, these systems allow water to be reused in vegetable gardens, landscaping, and other green areas, supporting sustainable water management.

Other reuse solutions are also important, such as filtering gardens (also known as water treatment gardens) and banana circles, which can be used to treat gray water.

Image: Joel Reichert / Collection: Instituto Alana

↑ Rainwater can also be stored in barrels for specific uses, as seen at a school in Novo Hamburgo, Brazil.

A.1 Rainwater harvesting and reuse (cisterns)

Cisterns are important tools for making schools more resilient. They are designed to capture and store rainwater, especially for non-potable uses such as flushing toilets, irrigating gardens, and cleaning outdoor areas. A typical collection system includes gutters, downspouts, leaf filters, and devices to discard the first flush — the initial runoff that carries dirt and debris from catchment surfaces — helping improve the quality of stored water.

Cistern solutions can range from small tanks holding 200 to 1,000 liters for specific, localized uses, to large systems with capacities of several thousand liters integrated into the school's water supply infrastructure. Choosing the right model should take into account the regional climate, available catchment area, the school's water demand, and the intended uses of the stored water.

EFFECTIVE PRACTICES

"One Million Cisterns," Brazil[51]

Developed by the Articulação Semiárido Brasileiro (ASA) (Brazilian Semi-Arid Alliance), this program addresses the basic need for access to potable water for rural populations. To decentralize and democratize access, cement-plate cisterns are built for families living in rural areas of the semi-arid region. The program incorporates water storage and use within municipal education policies.

"Water for Schools," Rwanda[52]

In recent years, the Water for Schools project has installed cisterns in schools across the country, with complete systems for collection, filtration, storage, and distribution to drinking fountains. In addition, the service includes monitoring equipment operation, checking water quality, and providing training on water, sanitation, and hygiene.

Image: Vivian Alessandra Vieira de Carvalho Souza / Collection: Instituto Alana

↑ A group of students in Codó, Brazil, installing a water reuse system. Winners of the 2025 Criativos da Escola (School Creatives) award, representing the Cerrado biome (the Brazilian tropical savanna).

CISTERNS

⚠ Key points

Roofs located near trees tend to collect leaves, which can compromise the quality of harvested water if not pre-treated. It is advisable to place cisterns in shaded areas, where cooler temperatures help preserve water quality. For underground cisterns, it is essential to ensure that the construction method allows safe burial without weakening the structure. In areas with a high water table, the cistern must be anchored to an underground base to prevent it from being lifted when empty.

▲▲△ **Maintenance** light to moderate

Gutters, downspouts, filters, and first-flush devices should be cleaned regularly. For larger cisterns with pumps and disinfection systems, maintenance needs may be greater, requiring specialized labor to repair electrical components such as pumps, valves, or advanced filters.

▲△△ **Cost** low

Simple arrangements, such as mini-cisterns, are inexpensive and easy to build — even as student workshop projects. However, larger systems with higher storage capacity involve greater expense.

◆ Best suited for

Outdoor spaces.

Recreational and educational aspects

- Expand awareness of the direct relationship between water availability and the seasons, fostering an understanding of the cyclical nature of water and encouraging more conscious use.
- Promote understanding of water’s finite nature and how conceptually simple harvesting technologies can increase the supply of good-quality water.

Environmental challenges addressed

- Localized flooding.
- Water scarcity.

Benefits of the solution

- Greater water self-sufficiency.
- Opportunities for learning as part of quality climate education.
- Improved learning environment and overall well-being.

CISTERNS

A cistern is used to capture and store rainwater for non-potable purposes.

rainwater harvesting detail

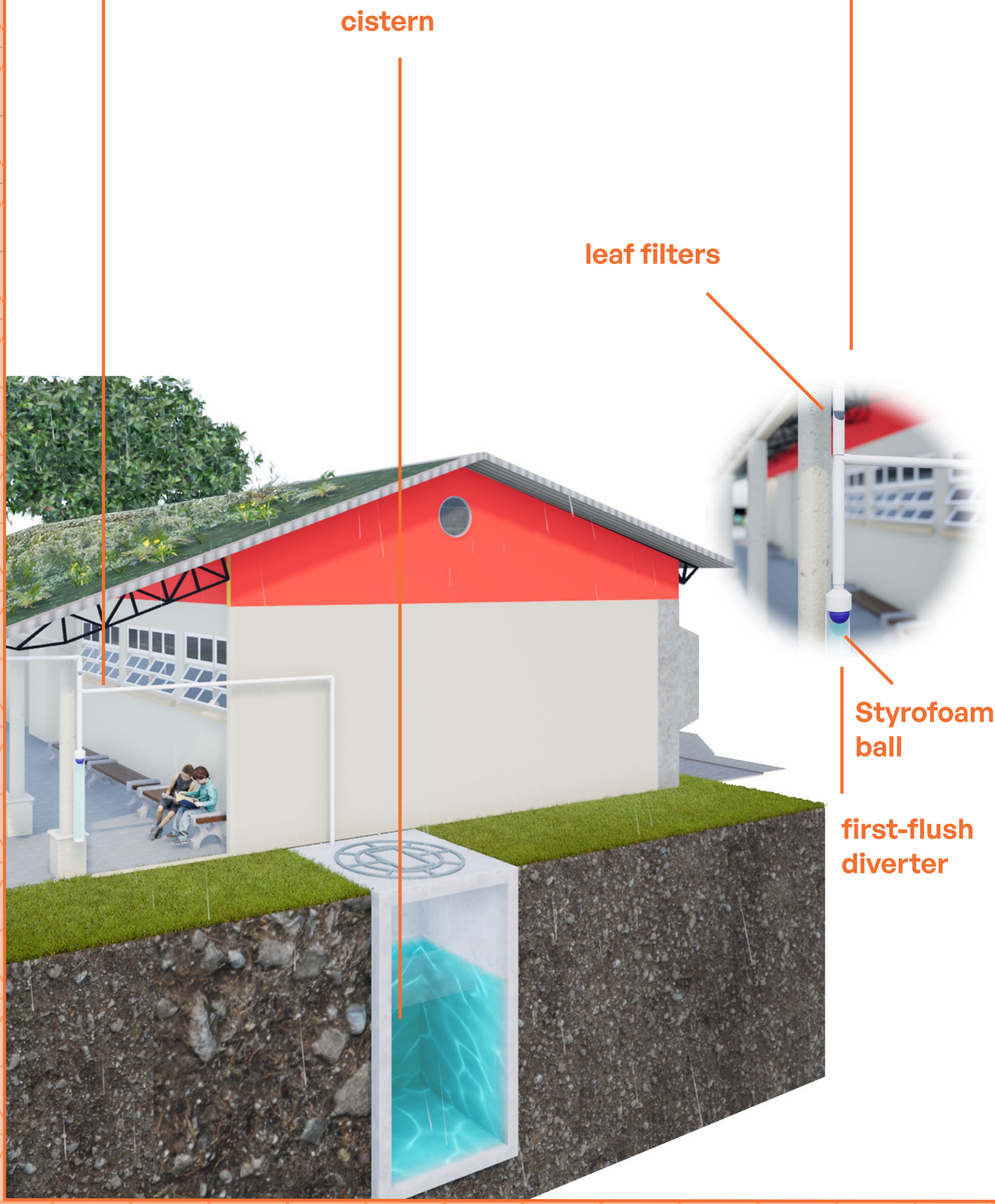


Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

A.2 Rain gardens

A rain garden is a shallow landscaped area that collects and absorbs stormwater runoff from rooftops, sidewalks, streets, and other impermeable surfaces. This helps reduce the volume of water entering conventional urban drainage systems. Ideally planted with native species that tolerate both dry periods and flooding, rain gardens support infiltration, evapotranspiration, and soil stability. They also boost local biodiversity by providing habitat for microfauna, including amphibians, which in turn help control mosquito populations.

Image: Paula Mendonça / Collection: Personal archive

↑ Rain garden installed in the Butantã neighborhood, São Paulo, Brazil.

EFFECTIVE PRACTICES

Mount Tabor School, Portland, Oregon, United States [53]

In 2006, the school was a pioneer in removing pavement from its parking lot to create a living, multifunctional space. The greening project transformed the area into a series of rain gardens covering 185 m^2, capturing runoff from nearly 3,000 m^2. This reduced flooding in basements of nearby houses and saved more than US$100,000 in drainage infrastructure costs. One of the most meaningful aspects was giving students, staff, and the community an opportunity to learn about environmental issues, sustainable rainwater management, and to experience daily contact with nature.

The second phase of the project addressed rainwater management in the plaza and parking area surrounding the school, through collection and storage in a 130 m^2 rain garden and a bioswale.[54]

RAIN GARDENS

⚠ Key points

Rain gardens have the greatest positive impact when installed in areas where the soil allows water infiltration. Floodplains with a high water table and regions with extremely clay-rich soils are not suitable. Ideally, they should be placed at least two meters away from building foundations and walls, and designed so that standing water lasts no more than 48 hours after rainfall. This prevents mosquito larvae from developing, as they are naturally controlled by the local microfauna. The garden's infiltration layer must also be at least 1.5 meters above the water table during the rainy season.

▲△△ **Maintenance** light

Requires removing debris carried in by rain, keeping the soil surface covered with dry leaves, replanting species that struggle to grow during the adaptation period, occasional pruning, and irrigation during prolonged dry spells.

▲△△ **Cost** low

Involves excavation, surface tilling, planting, and sometimes shallow connections to drainage networks.

◆ Best suited for

Outdoor spaces.

RAIN GARDENS

Recreational and educational aspects

- Expands understanding of the water cycle, especially the harmful effects of increasing impermeabilization in urban areas and measures that can minimize this impact.
- Provides sensory stimulation — including for students with visual impairments or other needs — through plants with different textures, colors, aromas, and flavors.
- Demonstrates in practice how water moves underground and recharges aquifers.
- Incorporates aesthetic and ecological elements, enabling learning about microclimates and urban biodiversity.
- Teaches about plant species and biodiversity.

Environmental challenges addressed

- Extreme heat.
- Localized flooding.

Benefits of the solution

- Water self-sufficiency.
- Biodiversity regeneration and strengthening of healthy local ecosystems.
- Learning opportunities for quality climate education.
- Improved learning environment and well-being.

RAIN GARDENS

A school rain garden reduces the risk of localized flooding and creates opportunities for teaching about water drainage.

vegetation

planting substrate

Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

A.3 Stormwater planters

A stormwater planter — technically known as a bio-retention cell — is a rain garden adapted to a small urban space. It serves the same function of collecting and absorbing runoff from impermeable surfaces. Due to its compact size, it is ideal for small urban areas.

As with a larger rain garden, the water collected in a stormwater planter should drain within a few hours following light to moderate rainfall and within 24 to 48 hours after a heavy storm. This prevents the proliferation of insects, algae, and bacteria. The planter must always include an overflow outlet to control surges and may also be connected to the existing conventional drainage system to redirect excess water. Additionally, stones are used at the inlet to dissipate the energy of incoming water.

Image: Gabriella Ornaghi / Collection: Gabriella Ornaghi e Bianca Vasone Arquitetura da Paisagem

↑ Stormwater planter filtering captured rainwater and gray water, using species suited to these conditions such as Wedelia, Taro, Papyrus, and Ipomoea vine (on the wall).

STORMWATER PLANTERS

⚠ Key points

Impermeable planters may be built near building foundations, provided they are fully watertight. Planters with filtration beds require greater depth than simple rain gardens; this demands special attention to the groundwater table, which should remain below the excavation level even during the rainy season.

▲▲△ **Maintenance** light to moderate

Maintenance is light if the planter is constructed similarly to a rain garden, without stones beneath the planting substrate. Moderate maintenance is required if the planter includes filtration beds with a sub-drainage system, i.e., with stones installed under the planting substrate. In the latter case, it may be necessary to replace the stones when particles accumulate.

▲▲△ **Cost** low to medium

The cost is low if constructed similarly to a rain garden, somewhat higher if it involves filtration beds with a sub-drainage system connected to the conventional drainage network.

◆ Best suited for

Outdoor spaces.

Recreational and educational aspects

- Expands understanding of the water cycle, especially the harmful effects of increasing impermeabilization in urban areas and measures that can help minimize such impacts.
- Provides sensory stimulation — including for students with visual impairments or other needs — through plants with different textures, colors, aromas, and flavors.
- Demonstrates in practice how water moves through subsurface flows and into groundwater.
- Incorporates aesthetic and ecological elements, allowing learning about microclimates and urban biodiversity.
- Teaches about plant species and biodiversity.
- Offers hands-on demonstrations of concepts such as soil permeability, water conservation, and the impacts of urbanization.

Environmental challenges addressed

- Extreme heat.
- Localized flooding.

Benefits of the solution

- Water self-sufficiency.
- Biodiversity regeneration and strengthening of healthy local ecosystems.
- Opportunities for high-quality climate education.
- Improved learning environment and well-being.

STORMWATER PLANTERS

A stormwater planter collects rainwater and provides diverse sensory stimuli.

Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

A.4 Biological reflecting pools and constructed natural ponds

These structures, designed to have year-round water surfaces, can range from small reflecting pools made with ground lining, such as plastic containers, to masonry constructions or larger excavated ponds. Integrated into the school's outdoor environment, they receive rainwater from rooftops and open spaces, storing it for long periods. In doing so, they allow solid particles to settle, reduce pollutants through sedimentation and biological processes, and, if properly maintained, can support aquatic life. They also serve as spaces for contemplation and leisure, contributing to environmental comfort, mental health, and daily contact with nature in school life. It is common to use aquatic plants and stones around the water to shape edges and create a more natural appearance.

Image: Paula Mendonça / Collection: Instituto Alana

↑ At Bosque School in Outeiro, Brazil, a constructed natural pond sits within gathering and circulation areas. It stores rainwater and provides habitat for local plants and animals.

BIOLOGICAL REFLECTING POOLS AND CONSTRUCTED NATURAL PONDS

⚠ Key points

- Shallow reflecting pools tend to heat up quickly under sun exposure, which can lead to the need for constant water replacement. In such cases, it is advisable to provide shade and to landscape around the pool to reduce wind exposure, thereby minimizing water loss through evaporation. Otherwise, a drainage system must be in place.

BIOLOGICAL REFLECTING POOLS AND CONSTRUCTED NATURAL PONDS

- Small reflecting pools should also contain fish that feed on mosquito larvae, creating a biodiverse, healthy, and safe environment.
- The use of water pumps can help control mosquito larvae by circulating the water, but the energy cost must be considered.
- The type of soil and the presence of groundwater should be assessed during the design phase to ensure that the chosen impermeable lining material is compatible with local conditions.
- If impermeable lining is not used, the ability of excavated ponds to hold water through the dry season must be evaluated. This option requires clay-rich soil and a water balance study to confirm that water loss through evaporation during dry months will be lower than water input during rainy months, ensuring a year-round water surface.
- Floating aquatic plants reproduce quickly, and their excess must be removed. This biomass can be valuable for soil cover in rain gardens and vegetable plots, or even for composting. In contrast, emergent aquatic plants (macrophytes) are rooted in the soil (or attached to floating structures) and grow above the water surface.

▲▲△ **Maintenance** light to moderate

They may require frequent removal of floating aquatic plants and annual or biannual pruning of emergent aquatic plants. Reflecting pools with recirculation pumps and filters demand a higher level of maintenance.

▲▲△ **Cost** low to medium

Small reflecting pools can be built with simple materials, keeping costs low. Constructed natural ponds, on the other hand, are larger structures that significantly affect school infrastructure and can be more costly.

BIOLOGICAL REFLECTING POOLS AND CONSTRUCTED NATURAL PONDS

◆ Best suited for

Outdoor spaces.

✠ Recreational and educational aspects

- Provide spaces for play, contemplation, and well-being.
- Can serve as outdoor classrooms for science lessons on aquatic ecosystems, the water cycle, and natural water purification processes.
- Enable the development of interdisciplinary projects on themes such as sustainability and microclimates.

▼ Environmental challenges addressed

- Extreme heat.
- Localized flooding.
- Low humidity.

★ Benefits of the solution

- Biodiversity regeneration and strengthening of healthy local ecosystems.
- Opportunities for high-quality climate education.
- Improved learning environment and well-being.

BIOLOGICAL REFLECTING POOLS AND CONSTRUCTED NATURAL PONDS

A constructed natural pond stores water and provides space for leisure and contemplation.

Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

A.5 Wastewater treatment gardens

Commonly known as constructed wetlands, treatment wetlands, or root-zone systems, these are engineered systems designed to treat wastewater. The liquid is directed into an impermeable tank filled with filtering material, where aquatic plants grow. This creates a rich environment of interaction among plants, microorganisms, soil, and water. These systems promote pollutant removal, nutrient reduction, oxygenation, and biological filtration, producing water safe for reintegration into the environment. In specific designs, they can also provide water for reuse. These gardens play an important role in the water purification process, complementing traditional septic tank–filter systems and producing water suitable for infiltration.

Image: Sarah Daher / Collection: Guajava

↑ A collaborative project by Vertical Garden, Guajava, and Fluxus Design includes a constructed wetland to treat wastewater generated at Cidade Jardim Station (CPTM commuter rail) in São Paulo, Brazil.

⚠ Key points

- Before reaching the gardens for treatment, water must pass through some type of tank where coarse materials can be removed. Otherwise, these materials may clog the filtering medium, blocking its function.
- Horizontal-flow treatment gardens tend to produce water with a sulfur odor due to the decomposition of organic matter in water. For this reason, infiltration after treatment is recommended instead of exposing the water on the surface.
- Designing gardens to produce water for reuse requires specialized technical knowledge.

▲▲△ **Maintenance** moderate

This system requires periodic maintenance of the pre-treatment tank to prevent solids from reaching the filtering medium, especially in horizontal-flow gardens. It also requires frequent checks of the water flow to ensure the medium is not clogged, as well as biannual pruning of plants.

▲▲▲ **Cost** medium to high

Building small experimental models and educational prototypes is less expensive. However, systems designed to treat the full volume of water generated by a school can be considerably more costly.

◆ Best suited for

Outdoor spaces.

WASTEWATER TREATMENT GARDENS

Recreational and educational aspects

- Provide practical examples for teaching wastewater treatment and natural water purification processes.
- Create a learning space about water conservation and the reuse of non-potable water.
- Teach about plant species with filtering capacity.
- Raise awareness of the impacts of human activity on the environment — especially in urban centers — along with types of water pollution and ways to address them.

Environmental challenges addressed

- Extreme heat.
- Water scarcity.

Benefits of the solution

- Water self-sufficiency.
- Learning opportunities that support high-quality climate education.

WASTEWATER TREATMENT GARDENS

A wastewater treatment garden uses natural processes to treat school wastewater.

infiltration trench with fruit trees

pre-treatment

screening chamber

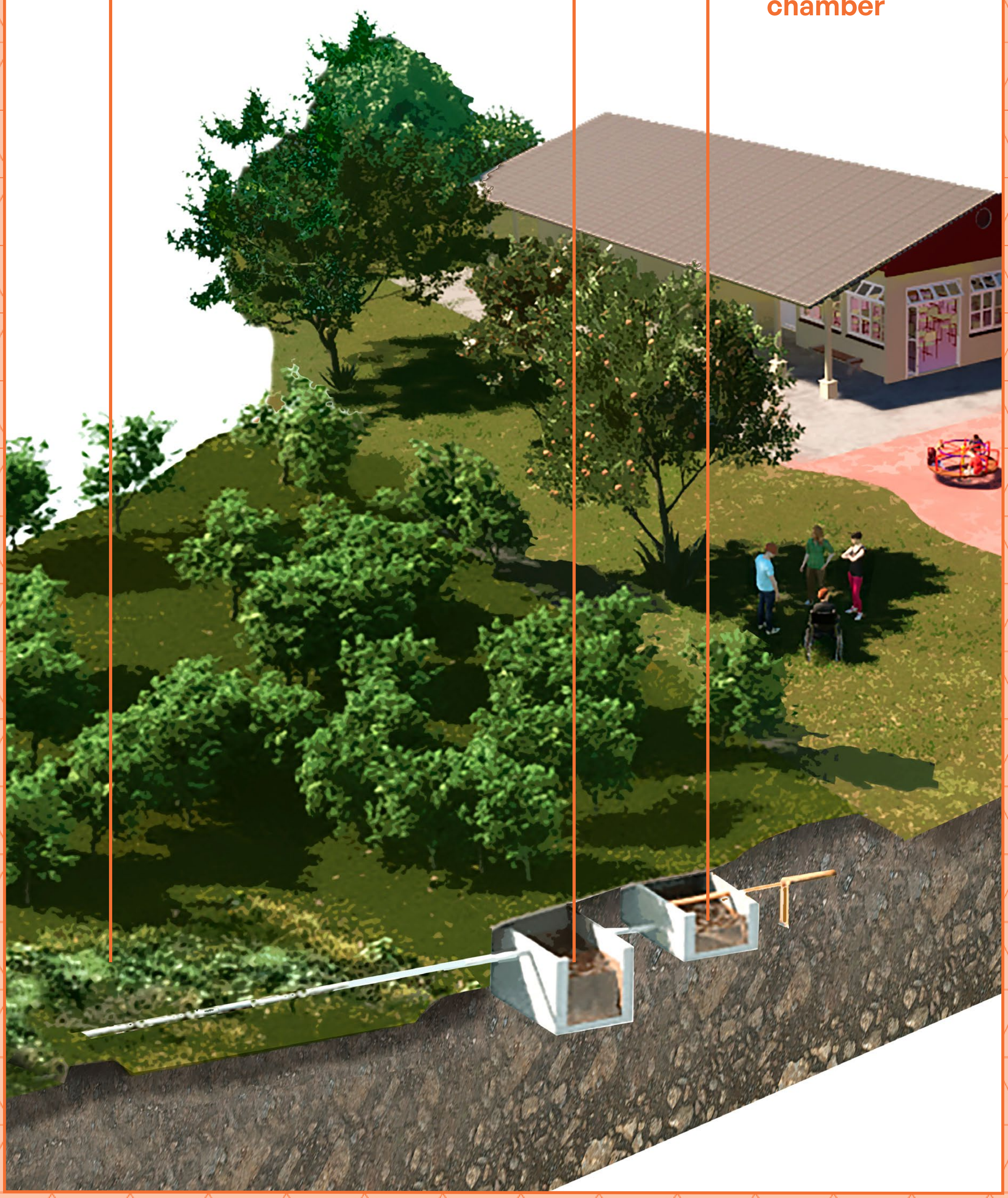


Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

B Thermal regulation

Schools located in urban areas experience the urban heat island (UHI)* effect.[55] As a result, students and staff who spend long hours on the premises face conditions that can affect their health and learning. School facilities should therefore be designed to provide healthy, comfortable indoor and outdoor environments that promote well-being. Buildings must provide thermal comfort through appropriate materials and construction solutions that moderate indoor temperatures, as well as through the integration of trees and vegetated spaces. These provide shade and foster evapotranspiration — processes that help reduce temperatures and support the restoration of the urban hydrological cycle.

In addition, construction techniques such as green roofs and green walls contribute to thermal regulation by storing and releasing heat gradually. They also enhance water absorption and evaporation, complementing the benefits offered by trees and other plants. These solutions reduce the need for artificial cooling systems, maintaining more moderate temperatures inside school buildings.

* [EXPLANATORY NOTE] An urban heat island occurs when a city experiences much warmer temperatures than nearby rural areas. The difference in temperature between urban and less-developed rural areas has to do with how well the surfaces in each environment absorb and hold heat.

In addition to their educational role, schools can serve as important climate shelters, especially during periods of extreme heat. A school environment that is resilient and adapted to climate change improves the microclimate in its immediate surroundings, supports carbon capture,* and provides healthier, more pleasant spaces.

* [EXPLANATORY NOTE] Through photosynthesis, plants capture carbon from the atmosphere — a substance responsible for the greenhouse effect but also an essential component of roots, stems, trunks, branches, and leaves.

EFFECTIVE PRACTICES

Refresca SP Project, São Paulo, Brazil

A partnership between the City of São Paulo and Instituto Alana, the Refresca SP project expanded green areas in schools and their surroundings, creating cooler microclimates through NbS. The initiative integrates climate education into the full-day school curriculum and involves students, educators, and the community in a participatory way. A pilot project was carried out at Virgílio de Mello Franco Municipal Elementary School, with the greening of the schoolyard.

Image: Kiko Medici / Collection: Instituto Alana

BEFORE

↑ The schoolyard at Virgílio de Mello Franco Municipal Elementary School in São Paulo, Brazil, consisted mainly of artificial structures and impermeable synthetic ground cover, offering few intentionally designed or engaging spaces and contributing to rising temperatures and thermal discomfort.

Image: Edilson Cruz / Collection: Instituto Alana

AFTER

↑ The Refresca SP pilot project at Virgílio de Mello Franco Municipal Elementary School in São Paulo, Brazil, introduced strategies to reduce extreme heat by incorporating natural elements, planting a variety of tree species, and expanding permeable ground areas.

Green areas help restore environmental functions by regulating the microclimate and encouraging the reproduction and circulation of pollinators and small animals. Implementing Nature-based Solutions (NbS) in schools can therefore contribute to increasing local biodiversity, while also creating multifunctional green space.

Image: Tibico Brasil / Collection: Instituto Alana

↑ Natural furnishings and newly created environments in the greened park at João Hildo Early Childhood Education Center in Fortaleza, Brazil, have been transformed into outdoor classrooms.

B.1 Green islands and mini-forests

Densely planted trees in open areas can replicate natural ecosystems on a smaller scale. They provide shade, improve air quality, increase biodiversity, capture carbon, regulate local temperatures, and create opportunities for environmental education. Their presence enhances evapotranspiration, which stimulates local rainfall. Tree roots support water infiltration and recharge groundwater, which feeds springs and rivers and helps balance the water cycle. Tree canopies reduce the impact of rainfall on the soil, keeping it more permeable, and slow the runoff flow, helping to mitigate flood peaks. These systems also help conserve springs and catchment areas, protect soil from erosion, and prevent the silting of water bodies.

To be effective, it is essential to understand the local environment, select appropriate species — giving priority to native and local plants — and consider how the vegetation will affect the space, such as whether it creates barriers, provides shade, offers trunks for climbing, or has root systems that impact the soil. It is also possible to design “aromatic gardens” with herbs, spices, and teas, or include plant species with varied flowering seasons. Toxic plants should be avoided.

When enriched with compost and other amendments, soil provides the nutrients needed for trees and

shrubs to grow. Adding substrate can further improve drainage and water retention, especially in compacted soils. Plant species should be chosen according to the region's climate and ecology, ensuring diversity in textures, sizes, and flowering periods, and including local fruit-bearing and medicinal plants. A layer of organic matter, such as straw, dry leaves, or bark, helps keep the soil moist and reduces weed growth.

It is advisable to plan a temporary irrigation system during the early years to help seedlings take root and grow.

Image: Tuane Fernandes / Collection: formigas-de-embaúba

↑ The organization formigas-de-embaúba promotes outdoor ecological literacy activities and participatory planting of mini-forests.

EFFECTIVE PRACTICES

formigas-de-embaúba, State of São Paulo, Brazil [56]

The nonprofit organization **formigas-de-embaúba*** promotes environmental education through participatory planting of mini-forests in schools and public facilities across the State of São Paulo. Its initiatives engage communities in building climate resilience, improving health, and fostering food production, while also drawing on and creating shared memories and emotional connections. Mini-forests support biodiversity, regulate the microclimate, enhance water infiltration into the soil, and create habitats for pollinators and birds. In this way, the organization expands the reach of community-based methods and planting technologies aimed at mitigating the effects of the climate emergency in vulnerable urban areas.

* [EXPLANATORY NOTE] The name *formigas-de-embaúba* is inspired by the symbiotic relationship between the *embaúba* tree and the ants that inhabit it. The embaúba is native to the Atlantic Forest, a biome that extends along much of Brazil's coastline. Ants live inside its trunk, which is vital to the tree's health. It is an example from nature of the importance of coexistence among species.

GREEN ISLANDS AND MINI-FORESTS

▲△△ **Maintenance** low

Use native plants that require less frequent pruning to reduce maintenance needs.

▲△△ **Cost** low

Access to natural elements — such as tree trimmings and seedlings — from local producers and partner establishments, along with growing seedlings at the school itself, are strategies to reduce both implementation and maintenance costs.

◆ Best suited for

Outdoor spaces.

Recreational and educational aspects

- Foster connection with nature and give students opportunities for leadership through hands-on planting and positive transformation of their environment.
- Allow observation of natural cycles as plant species change with the seasons — flowering, fruiting, life, and death.
- Create environments and landscapes for refuge and exploration.
- Enable activities to observe local fauna and flora, supporting learning about ecosystems and biodiversity.
- Provide students and teachers spaces for physical exercise, awareness-building activities, and meditation.
- Offer opportunities to study differences in ambient temperature according to space characteristics or land use (thermal comfort).

GREEN ISLANDS AND MINI-FORESTS

Environmental challenges addressed

- Extreme heat.
- Localized flooding.

Benefits of the solution

- Biodiversity regeneration and strengthening of healthy local ecosystems.
- Opportunities for learning and high-quality climate education.
- Improved learning environment and well-being.

GREEN ISLANDS AND MINI-FORESTS

Green islands in a school provide multiple benefits for community health and well-being, while also preserving biodiversity.

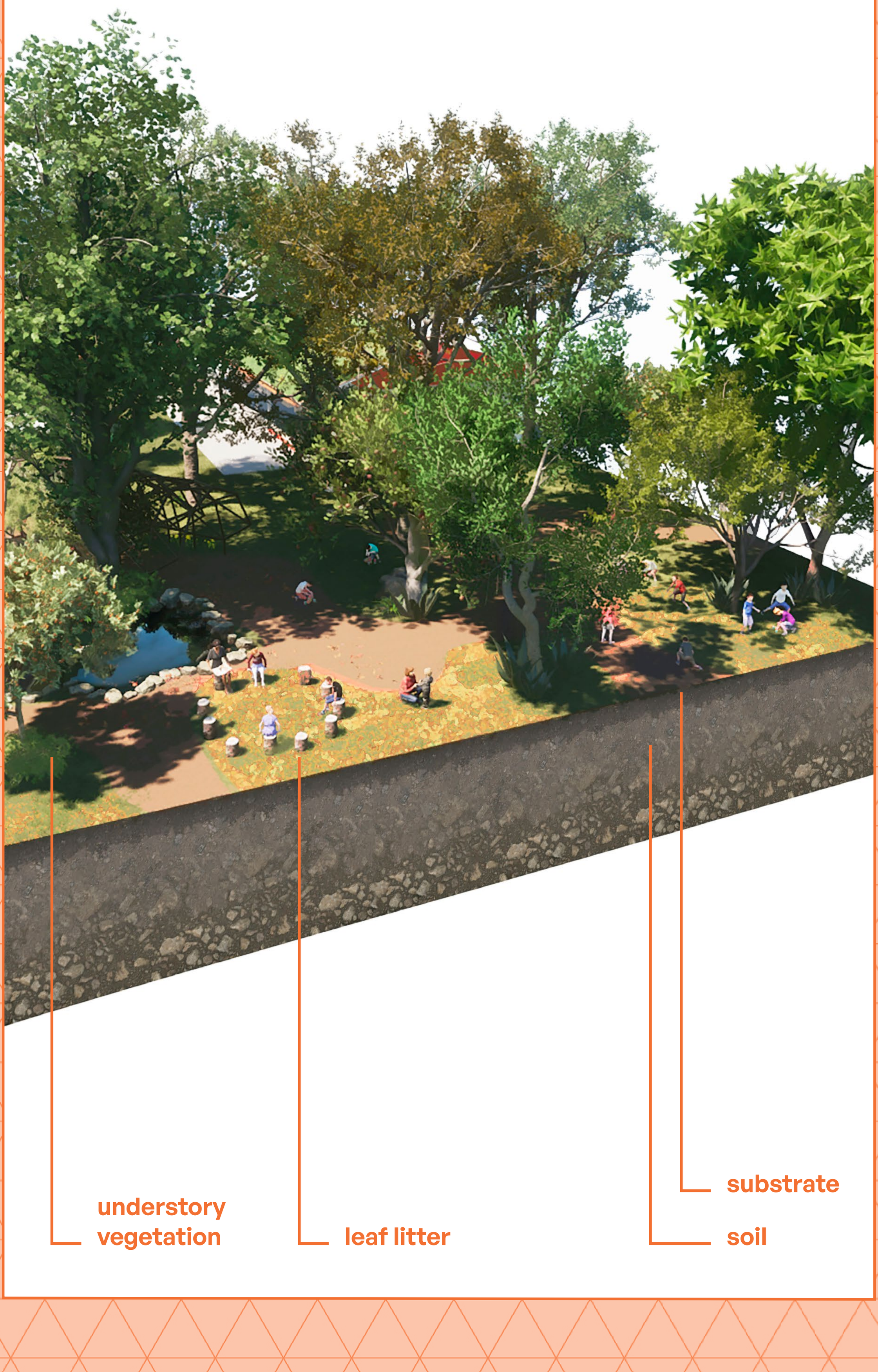


Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

B.2 Green roofs

A green roof is a specially designed rooftop structure that incorporates materials to support vegetation. Green roofs provide thermal insulation, reduce stormwater runoff, improve air quality, increase biodiversity, capture carbon, and help mitigate the urban heat island effect.

These structures can be built with lightweight materials for roofs with low load-bearing capacity, such as fiber cement, or with multilayer systems for slabs and other constructions with greater structural support.

Image: Gabriella Ornaghi
Collection: Gabriella Ornaghi e Bianca Vasone Arquitetura da Paisagem

↑ To address limited soil depth, a MacDrain drainage mat was installed for drainage, along with a resilient native Brazilian groundcover species well-suited to shallow soil, sun, and wind.

GREEN ROOFS

⚠ Key points

Green roofs must always be compatible with the building's structural capacity. For existing roofs that cannot support significant extra weight, prioritize lightweight solutions. When built on flat or low-slope slabs, they must include a waterproofing system that completely prevents water from seeping into the structure while allowing excess water to be directed off the roof. If waterproofing is applied, monitor roof surfaces during rainy periods to detect leaks, and follow technical recommendations for updating the material as specified by the supplier.

When combined with rainwater harvesting systems, it is best to use inert substrates with minimal organic matter, so that water quality is not significantly affected when in contact with the substrate.

▲▲△ **Maintenance** light to moderate

Use plants that require less-frequent pruning to reduce maintenance needs.

▲▲△ **Cost** low to medium

Building lightweight systems requires only a small investment, while green roofs with waterproofing, drainage, and substrates involve higher costs.

◆ Best suited for

Outdoor spaces and buildings.

Recreational and educational aspects

- Serve as living laboratories for teaching about sustainability, thermal insulation, and water management.
- When accessible, provide space to observe pollinators such as bees and butterflies.
- Offer practical lessons on the impact of green construction on the urban climate.
- Enable the study of plant species suited for rooftop cultivation, aligned with the applied technology and local biome.
- Allow research on temperature differences in the environment based on the construction materials used in walls and roofs.
- Play an important role in rainwater retention, reducing flooding by lowering runoff volumes during heavy rainfall.

Environmental challenges addressed

- Extreme heat.
- Localized flooding.

Benefits of the solution

- Biodiversity regeneration and strengthening of healthy local ecosystems.
- Opportunities for learning and high-quality climate education.
- Improved learning environment and well-being.

GREEN ROOFS

A green roof captures rainwater, lowers indoor temperatures, and improves air quality.

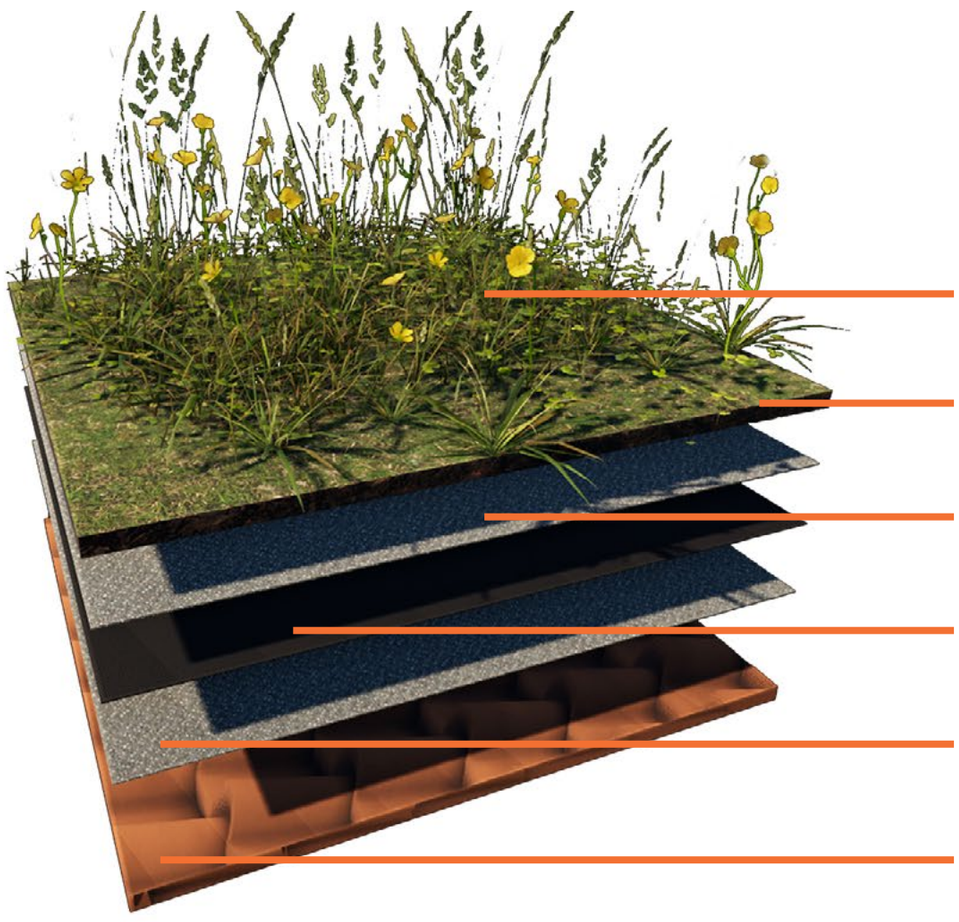


Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

EFFECTIVE PRACTICES

Teto Verde Favela (Green Roof Favela), Rio de Janeiro, Brazil [57]

Created by Luis Cassiano Silva, this initiative demonstrates a simple, affordable way to build green roofs in favelas. It combines hands-on guidance for purchasing materials and carrying out installations with environmental education activities for children. The project aims to improve air quality and reduce heat inside homes by using low-cost materials and native Brazilian plants.

Image: Luis Cassiano / Collection: Teto Verde Favela

↑ Green roof built on a home in a favela in Rio de Janeiro (Brazil), using low-cost materials and native plant species from the region.

EFFECTIVE PRACTICES

Lycée Français François Mitterrand, Brasília, Brazil [58]

The architectural project for the French School of Brasília, designed by architects José Luiz Tabith Jr. and Jean Dubus, won the international Brazil–France competition. Its design is integrated into the surrounding landscape, with open spaces accessible to the public. The buildings feature wide openings to the outdoors, encouraging interaction with greenery, natural light, and ventilation, while fostering biophilia.* Extensive green roofs on the buildings contribute to thermal comfort inside the spaces and allow the terraces to be used for educational activities.

* [EXPLANATORY NOTE] The term "biophilia," coined by the prominent biologist Edward O. Wilson, proposes that humans have an innate affinity with other forms of life — a love of living beings and of nature.

Image: Rafael Amador / Collection: José Luiz Tabith

↑ The French School of Brasília features classroom blocks connected by green outdoor spaces, making use of natural lighting and ventilation, and regulates indoor temperatures thanks to its extensive green roof.

B.3 Living tunnels

A living tunnel is a structure made of supports and climbing vegetation, creating a shaded space. It provides thermal comfort, improves air quality, and integrates with the natural landscape, making it ideal for leisure, circulation, or contemplation areas.

The supports can be made of wood, metal, or bamboo, ensuring the strength and durability needed to sustain climbing plant species. These species should be adapted to the local climate and soil, with fast growth and dense coverage, such as jasmine or passionfruit.

To help the vegetation establish, it is recommended to install an initial protective cover, such as shade netting or a similar material, until the climbers fully cover the pergola. The installation of wires, cables, or nets can also guide plant growth along the structure.

Image: Vilma Silva / Collection: Calore Ateliê

↑ A living tunnel is an excellent option for shade and can be used for walkways, covering spaces, and landscape design.

▲△△ **Maintenance** light

Native plants are generally better adapted to the climate and can often go without irrigation for most of the year.

When using bamboo or wood, apply a protective treatment beforehand to increase durability.

▲▲△ **Cost** low to medium

Costs are lower when using locally sourced natural materials and higher for structures made with more expensive materials, such as metal.

◆ Best suited for

Outdoor spaces.

Recreational and educational aspects

- Foster connection with nature by creating spaces for refuge and exploration, stimulating imagination and creativity.
- Incorporate aesthetic and ecological elements, enabling learning about microclimates, thermal comfort, and urban biodiversity.
- Support study of ecosystems and the ecological interactions between plants and local fauna.
- Encourage active observation of temperature differences in the environment depending on land use or spatial characteristics (thermal comfort).

LIVING TUNNELS

Environmental challenges addressed

- Extreme heat.
- Low humidity.

Benefits of the solution

- Biodiversity regeneration and strengthening of healthy local ecosystems.
- Opportunities for learning and high-quality climate education.
- Improved learning environment and well-being.

LIVING TUNNELS

In school settings, a living tunnel becomes a space for exploration and connection with nature.

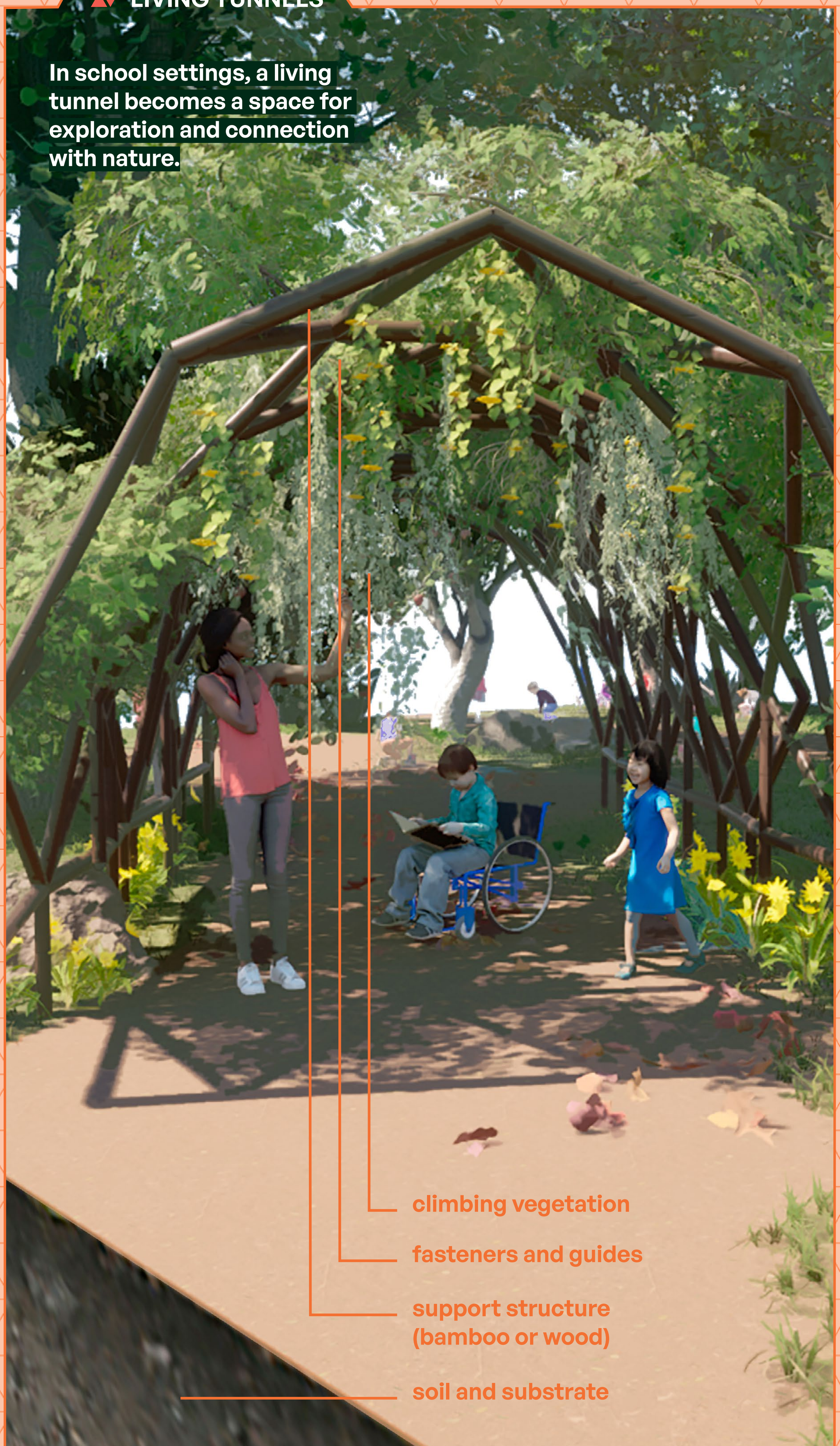


Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

B.4 Green walls with climbers

A green wall is a vertical structure covered with vegetation, designed to improve thermal comfort, reduce air pollution, and provide acoustic insulation. It can be applied to exterior or interior façades, making it a good option for schools with limited open space or playground areas.

Green walls can range from simple wall fixings and ties made with sisal twine — supporting climbing plants adapted to local conditions — to more formal structures in wood or metal, designed together with an irrigation system that uses tubes or drippers to provide water and nutrients to the plants. In such cases, a waterproof layer must be installed between the wall and the green system to protect the building from leaks. The system must also include drainage to direct excess water away and prevent accumulation at the base of the wall. To avoid overloading the supporting structure, substrate layers should be lightweight and permeable, suitable for anchoring and plant growth.

Climbing species should be adapted to the site's specific conditions, preferably low-maintenance, with diverse textures, colors, and flowering cycles, sparking curiosity and enabling interaction with students throughout the year.

[REFERENCE] **Como fazer uma parede verde simples, comestível e barata!** (How to make a simple, edible, and inexpensive green wall!) (In Portuguese) — A video with practical instructions for building an accessible green wall.

GREEN WALLS WITH CLIMBERS

⚠ Key points

When intended to improve thermal comfort, this type of intervention works best on walls that receive strong afternoon sun, where heat transmission to the indoor environment is greatest.

▲▲△ **Maintenance** light to moderate

Green walls with support structures and irrigation systems also require pumping and drainage systems. These typically demand more maintenance than climbers planted directly in the soil and trained on a simple sisal twine grid, which can be replaced at low cost whenever needed. Irrigation systems generally require higher maintenance. For this reason, when selecting vegetation, priority should be given to species suited to the local climate that can go without watering for most of the year.

▲▲△ **Cost** low to medium

Costs decrease when the structure is lightweight and plants need minimal support, particularly if an irrigation system is not required.

◆ Best suited for

Outdoor spaces and buildings.

Recreational and educational aspects

- Incorporate aesthetic and ecological elements, enabling learning about microclimates and urban biodiversity.
- Demonstrate in practice concepts such as evapotranspiration and its impact on the environment.
- Stimulate creativity in artistic and architectural projects.
- Encourage the study of climbing species adapted to the site that offer valuable characteristics for the space, such as flowers, fruits, fragrances, and the attraction of pollinators.

Environmental challenges addressed

- Extreme heat.
- Low humidity.

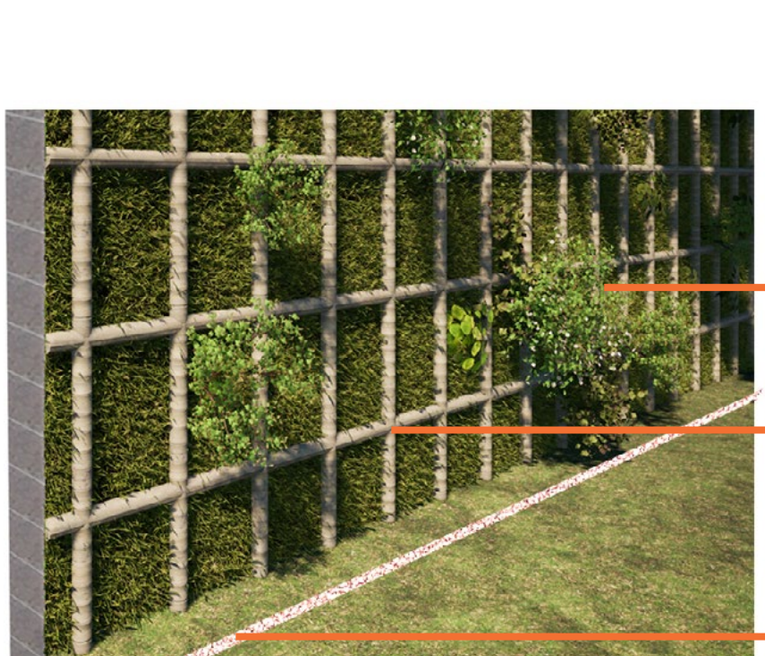
Benefits of the solution

- Biodiversity regeneration and strengthening of healthy local ecosystems.
- Opportunities for learning and high-quality climate education.
- Improved learning environment and well-being.

GREEN WALSL WITH CLIMBERS

Planting vegetation on walls not only provides diverse sensory stimuli but also helps lower the temperature of built spaces.

Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana



climbing and trailing plants

planting line

garden border

C Energy efficiency

Like the approaches to water efficiency described above (Section A of this chapter), efforts to improve energy efficiency begin with actions that raise awareness about per capita energy consumption in school buildings. This requires measuring local consumption, followed by adopting measures to reduce it, and eventually introducing local energy generation. These efforts can be supported by improvements that enhance cross-ventilation and natural lighting.

Effective architectural strategies include replacing conventional masonry with perforated walls (*cobogós*) and adding louvers (brise-soleil). These features allow natural light and airflow, reducing reliance on artificial lighting and air-conditioning. Positioning buildings to maximize cross-ventilation can further improve thermal comfort. Such practices are supported by studies on thermal and lighting performance in buildings.*

Construction materials also play a key role. Materials with high thermal inertia — those that absorb and release heat slowly, such as adobe and rammed earth

* [EXPLANATORY NOTE] For example, the studies conducted by the Laboratório de Conforto Ambiental e Eficiência Energética (LABAUT) (Laboratory of Environmental Comfort and Energy Efficiency) at the University of São Paulo, Brazil.

— help maintain stable indoor temperatures and reduce the need for mechanical heating or cooling.

Vegetation can also be integrated into the built environment through green roofs, rain gardens, living walls, and tree planting. These features help create more stable microclimates with higher humidity and lower temperatures, decreasing the demand for electricity used in cooling.

The use of solar water-heating panels can also play a significant role, especially in climates and school settings where hot water is needed. These systems can replace traditional electric showers, which have high power demand and can substantially increase a school's electricity consumption.

Efficient management of lighting and electronic equipment is equally important. Replacing conventional bulbs with LEDs, installing motion sensors, and using solar-powered lights can greatly reduce energy use. In addition, raising awareness among users about energy-saving practices is critical to maximize the benefits of these physical improvements, as studies highlight the strong influence of user behavior on the energy performance of school buildings.

Finally, the installation of renewable energy systems, such as photovoltaic solar panels, is another recommended measure. While the initial investment can be relatively high, it is often cost-effective over

the medium and long term, with potential for repayment through savings on electricity bills. Beyond meeting part of the school's energy needs, these systems also serve as educational tools, promoting sustainability awareness among teachers and students.

EFFECTIVE PRACTICES

Loren School, Oslo, Norway [59]

To improve environmental performance and reduce its ecological footprint, the Loren School combined a 500 m^2 green roof with photovoltaic panels to generate part of the energy it consumes. The project prioritized environmental responsibility, maintaining existing vegetation cover and biodiversity.

C.1 Natural lighting and ventilation

This category of design solutions for school buildings maximizes the use of natural light and air, improving thermal comfort, reducing energy consumption, and creating healthy environments.

New buildings can benefit from appropriate bioclimatic planning which, while requiring greater investment during the design phase, yields long-term gains throughout the building's life and fosters a healthier environment for all users. During health crises such as the COVID-19 pandemic, the importance of architectural design that enables high rates of air exchange has been evident, as it reduces the transmission of airborne diseases.

Openings such as windows, doors, and skylights should be aligned with the sun's orientation and prevailing winds at the school's location to optimize natural light and airflow. In summer, design should maximize ventilation and limit direct sunlight; in winter, the opposite should be prioritized. Cross-ventilation is achieved by placing openings on opposite walls, forcing air movement indoors and enhancing thermal comfort. Where wall openings are not feasible, light and ventilation shafts can be designed to channel daylight and airflow into interior or underground areas.

Shading devices such as brise-soleil, awnings, and external blinds can be positioned on building façades to control direct sunlight and prevent overheating. Translucent materials with thermal insulation properties can also admit diffuse light while reducing heat gain.

Image: Jaume Barnada.

↑ At Josep Maria Jujol School in Barcelona, the covered play area features a roof—listed by the city as a heritage structure—that allows natural light and air to flow through.

⚡ NATURAL LIGHTING AND VENTILATION

⚠ Key points

Natural lighting and ventilation solutions must be designed in relation to the local climate. For example, humidity from vegetation or small water features near buildings can be highly beneficial in dry climates but should be avoided in more humid ones. Similarly, permanent ventilation is useful in hot, humid climates, but in colder regions it should be adapted with devices that allow airflow to be controlled.

▲▲△ **Maintenance** light

Once installed, these systems require little maintenance, but it is recommended to:

- Check hinges and opening mechanisms to ensure that brise-soleil, windows, and awnings can be opened and closed easily.
- Avoid internal or external obstructions — such as furniture, opaque paint, added panels, or vegetation — that block airflow or natural light.
- Periodically clean glass and translucent surfaces to remove dust, dirt, or stains that could reduce natural light.

▲▲△ **Cost** low to medium

The choice of materials for windows, louvers, or roofing will determine the level of investment.

◆ Best suited for

Buildings.

NATURAL LIGHTING AND VENTILATION

Recreational and educational aspects

- Stimulate creativity in artistic and architectural projects.
- Encourage permeability between indoor and outdoor spaces, strengthening children's connection with nature — a core principle of caring for oneself, others, and the planet.
- Provide hands-on explanations of air density and air currents.
- Offer materials for studying temperature differences in the environment based on land use and spatial characteristics (thermal comfort).

Environmental challenges addressed

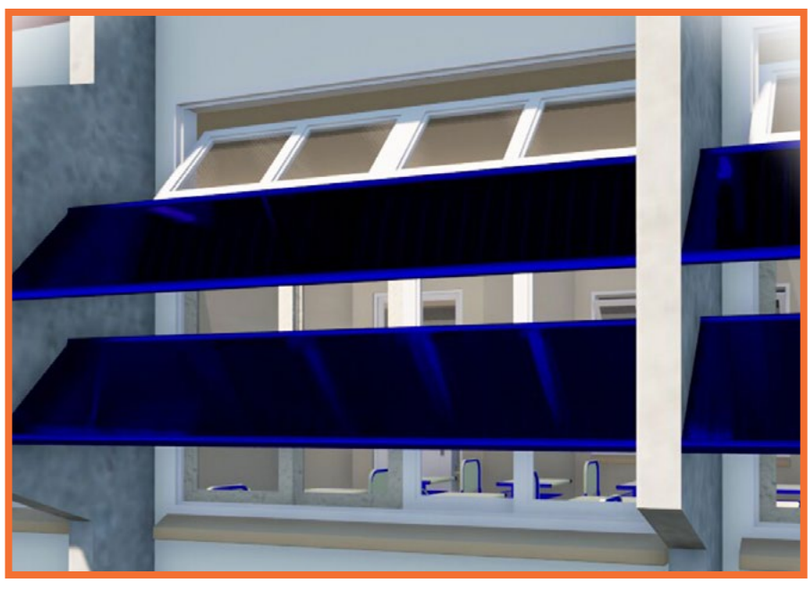
- Extreme heat.
- High humidity.

Benefits of the solution

- Opportunities for quality climate education.
- Improved learning environment and well-being.

NATURAL LIGHTING AND VENTILATION

Harnessing natural lighting and ventilation in school buildings reduces energy use and integrates indoor and outdoor spaces.



brise-soleil detail

brise-soleil

roof lantern

frames

cobogó

Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

C.2 Solar energy

Solar energy is captured directly from the sun's rays through panels installed on building rooftops. The two main uses are generating electricity and heating water.

Solar power is considered a renewable and sustainable energy source, helping to reduce greenhouse gas emissions and diversify the energy mix, while also lowering costs over time. Solar energy capture is a viable alternative to meet energy demand on different scales, from homes to large industrial facilities.

To maximize sunlight exposure throughout the day and increase energy generation, solar panels can be installed on technical slabs at the top of a building, on the uppermost floor, or on open ground-level areas and elevated terrain with little surrounding vegetation.

EFFECTIVE PRACTICES

Inspiring examples of clean energy in schools

- The State of Ceará, Brazil, created the **Fundo de Incentivo à Eficiência Energética (FIEE)** (Energy Efficiency Incentive Fund) to support projects using renewable sources. In 2023, 29 state schools received photovoltaic systems.
- Since 2010, the **Instituto Favela da Paz**, São Paulo, Brazil, has promoted sustainability and entrepreneurship in the Jardim Ângela district. With student participation, it has already installed solar energy systems and biodigesters in homes and public spaces in the area.[60]

SOLAR ENERGY

⚠ Key points

Solar panels must be positioned in the optimal direction to receive the most sunlight hours across all seasons, with the tilt angle adjusted according to the building's latitude, ensuring maximum direct exposure.

The weight of the panels should be factored into the roof's load-bearing capacity, especially in systems for heating water that use a thermal storage tank (boiler) on the roof.

▲▲△ **Maintenance** light to moderate

Panels require annual cleaning and washing to maintain efficiency in converting sunlight into energy, whether electrical or thermal. While most system components are protected against corrosion caused by sea air, attention should be given to the materials used in the mounting structures, which must also be resistant.

▲▲▲ **Cost** medium to high

The technology, materials, and manufacturing method will determine the level of investment.

◆ Best suited for

Outdoor spaces and buildings.

SOLAR ENERGY

Recreational and educational aspects

- Serves as a living laboratory to teach about sustainability and energy generation and use.
- Enables study of energy systems and renewable energy sources.

Environmental challenges addressed

- Energy scarcity.

Benefits of the solution

- Energy self-sufficiency.
- Opportunity for high-quality climate education.

SOLAR ENERGY

Solar panels installed on a building's roof, oriented toward the side that receives the most sunlight.

Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

D Furniture and landscape design

Landscape design and the choice of furnishings are essential dimensions in creating schoolyards that encourage play, learning, and social interaction in contact with nature. More than simply organizing or beautifying the space, these elements carry a strong educational dimension: they invite action, interaction, and learning, stimulating children's autonomy, imagination, and motor and emotional development. In practice, landscape design brings together multiple elements, described below.

Image: Gilles Lecuir

↑ At Ecole Élementire Jules Verne in France, outdoor spaces with organic elements and shapes foster curiosity.

Topography becomes an important resource in landscape projects. Small mounds, trenches, tunnels, ramps, and slopes not only create physical and sensory challenges but also foster direct contact with the soil, encourage children to take ownership of the space, and support stormwater drainage and temporary storage. A varied topography expands the possibilities for use and contributes to a less monotonous, more stimulating environment.

Using furnishings made from natural resources — locally sourced, low-impact materials such as logs, branches, stones, bamboo, or reclaimed wood — together with planting, reduces reliance on industrial and nonrenewable materials and cuts down on inorganic, hard-to-decompose waste.

Planting fruit trees and shrubs, preferably native species, allows for interaction, temperature control, shaded areas, and the strengthening of local biodiversity. In this way, multifunctional spaces can be created, including areas for rest, play, educational workshops, or for group gatherings and outdoor meals.

It is important to design pathways that connect these spaces, ensuring accessibility and accounting for the circulation of people during different school activities. Furniture, topography, plantings, and pathways together shape the landscape — defining areas, creating access routes, garden beds, and mazes — making

the environment more beautiful, pleasant, and rich in outdoor experiences.

Educational gardens also provide a valuable teaching tool and access to healthy food. Combined with gardening, composting at school allows children to learn about production and disposal cycles while observing how materials considered waste are transformed into rich organic fertilizer for use in the school's planting areas.

The space should meet the needs of the entire school community, offering exploration areas for different age groups as well as places for challenge, rest, physical activity, and social connection. Arranging the space in this way supports intergenerational use and deepens the sense of belonging across the whole school community. Outdoor spaces create opportunities to strengthen bonds, encourage cooperation, and cultivate care for one another and for the environment.

⚠ Key points

When adapting infrastructure, planting and natural elements alone are sometimes not enough to address the impacts of climate events, especially in areas prone to flooding. For this reason, we recommend also considering structural measures — for example, raising the ground floor level and relocating rooms with important documents or high-cost equipment to upper floors — to prevent losses and minimize damage.

It is also advisable to study the feasibility of installing control devices on ground-floor openings — such as floodgates, valves, and pumps — as well as creating intermediate-level spaces (such as mezzanines) to protect materials.

Climate change adaptation must include a careful focus on preventing losses and reducing damage, and structural measures can play an important role in this planning.

D.1 Play elements

A nature-based space designed for play and community interaction includes interactive features, toys, and furnishings for both children and their caregivers or family members. When creating these elements, it is best to make use of the site's topography and natural, unstructured materials already present in the landscape, or to install wooden toys and furnishings that blend with the space and the concept of a green schoolyard. It is important to combine conventional playground equipment, such as swings, slides, and playhouses, with natural play elements. This helps introduce and reinforce the concept of the green schoolyard as a true play space.

[REFERENCES]

Guide on Natural Play Structures and Furniture
A resource offering inspiration and practical guidance for creating and maintaining natural play elements.

Paths for Implementing Natural Play Spaces: A Guide for Public Managers
A publication on designing projects and public policies that incorporate natural parks and schoolyards.

Image: Alex Herzog

↑ At Escola da Vila in Lisbon, Portugal, trimmings from local trees were reused to build playground equipment.

PLAY ELEMENTS

▲△△ **Maintenance** light

▲△△ **Cost** low

◆ **Best suited for**

Outdoor spaces.

Recreational and educational aspects

- Expand play-based learning opportunities to older age groups.
- Provide practical examples of diverse ways natural elements can be used.
- Encourage free play that taps into both individual and collective creativity.
- Offer opportunities to compare experiences with play equipment made from natural materials and those made from other materials, such as plastic.
- Promote free and spontaneous play with natural elements, such as leaves, branches, stones, and water, that become toys and imaginative settings, stimulating creativity and imagination.
- Support outdoor activities such as running, jumping, climbing, and exploring, which promote physical development and motor coordination.
- Enable sensory experiences and walks that engage the senses through the smells, sounds, textures, and colors of nature.

★ Benefits of the solution

- Opportunity for high-quality climate education.
- Improved learning environment and well-being.

PLAY ELEMENTS

A school space with play elements and furnishings made from natural materials.

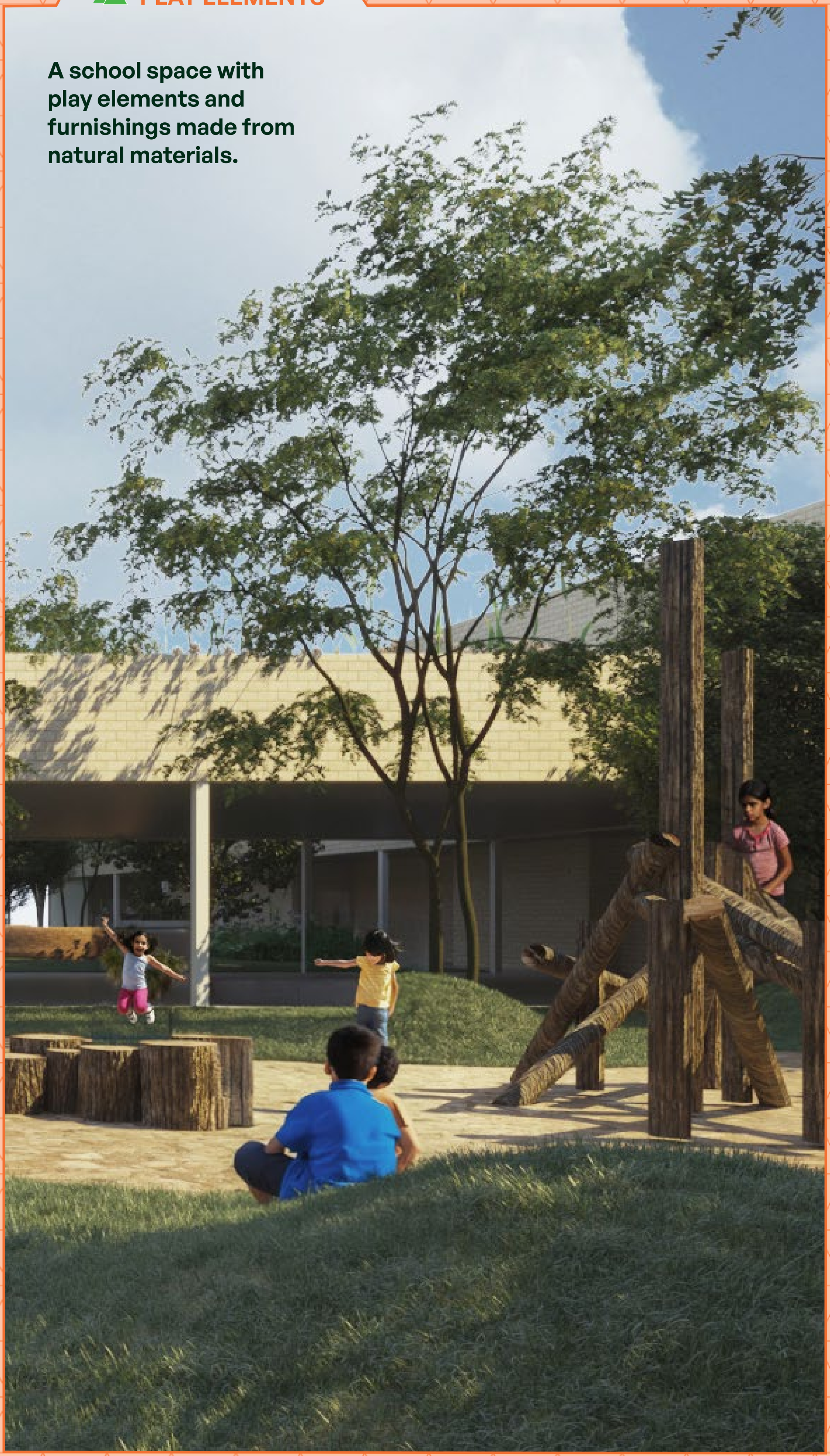


Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

D.2 Outdoor classrooms

Open-air classrooms are spaces created in the external areas of schools that provide learning experiences anchored in two pillars: learning **with** nature and learning **in** nature. In the first case, nature itself becomes the subject of study — for example, exploring plant physiology, photosynthesis processes, or water cycles, all common topics in the natural sciences. In the second, natural elements serve as teaching resources across different fields of knowledge. Mathematics lessons can involve measuring shadows and angles based on the sun's position; geometry can be explored through the shapes of leaves; and writing or storytelling skills can be developed through observation of a landscape. In this way, nature — or outdoor space — functions as a setting that supports well-being and creates a lively, inspiring environment for studying a wide range of subjects.

Outdoor classrooms can be furnished with large communal tables, ideally placed under the shade of tree canopies or beneath alternative structures such as pergolas, tarps, or fabrics. A common construction approach uses waterproofed wooden stumps set in a circle, with the buried section coated in asphalt paint for durability.

Image: Rinaldo Martinucci / Collection: Instituto Alana

↑ Jardim Helena Park in São Paulo, Brazil. Open-air classrooms are spaces for gathering, resting, and studying, and can be in shaded areas.

OUTDOOR CLASSROOMS

▲△△ **Maintenance** light

▲△△ **Cost** low

◆ **Best suited for**

Outdoor spaces.

Recreational and educational aspects

- Encourage activities that highlight differences in student presence and behavior compared to closed classrooms.
- Support activities that replicate the shapes, textures, and colors of natural elements through artistic and sensory creations.
- Provide opportunities for reading circles and group discussions.
- Enable interdisciplinary teaching strategies that connect the curriculum to real-life experiences — for example, measuring plants in math, observing insects in science, or making natural pigments in art.
- Foster investigative activities driven by children's curiosity, encouraging observation, questioning, and research.
- Allow for group dynamics and cooperative games that promote social interaction, active listening, and mutual care, supporting socio-emotional well-being.

★ Benefits of the solution

- Opportunity for high-quality climate education.
- Improved learning environment and well-being.

OUTDOOR CLASSROOMS

An open-air classroom arranged in a circle, with wooden stumps, large picnic tables for group activities, and other elements, offers children the chance to play and learn with and in nature — an investment in connection and meaningful learning.

Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

EFFECTIVE PRACTICES

Escola da Vila, Lisbon, Portugal[61]

The school is located within a protected area, the Alcântara Green Corridor. Its facilities, built with natural materials, are integrated into the landscape, allowing pedagogical activities to take place in open-air classrooms. Outdoor spaces are essential for experiential learning with nature and natural processes, developed according to permaculture principles. An ecological garden is one such space, located at the heart of the school. Free play is an integral part of the school routine, supporting the holistic development of children. Families actively participate in the many activities promoted by the school, including cultural festivals that celebrate life and natural cycles.

Image: Alex Herzog

↑ The mini-forest, the garden, and the paths connecting them at Escola da Vila in Portugal become open-air classrooms, offering spaces for gathering, resting, and studying.

D.3 Earthbag construction with soil-cement

Sustainable structures made from natural, low-cost materials — such as compacted earth in bags and mixtures of soil with cement or lime — offer both strength and thermal comfort. This construction method makes predominant use of local resources, since the soil available on site is the main input, ideally with sandy characteristics that improve compaction. To increase the strength and durability of the structures, the soil can be stabilized by adding cement, creating what is known as soil-cement.

In methods such as superadobe or hyperadobe, raffia or raschel bags are used to contain the soil and form compacted layers. Between these layers, barbed wire is placed to reinforce the structure and give the structure greater stability. Water is used both in preparing the soil-cement mixture and in moistening the soil in superadobe applications.

To standardize architectural elements such as benches, a form or guide is employed, acting as a mold. The final finish is done with a coating, preferably using lime mortar or natural plaster, which protects the structure from weather exposure and improves its appearance. The entire construction process can be carried out with simple hand tools, such as shov-

els, hoes, and tampers, making the technique accessible in contexts with limited resources.

This construction method can be applied in schools to build composting units and garden structures.

[REFERENCE] **Construção com terra (Building with earth) (in Portuguese)**
A video presenting earthen construction techniques.

Image: Ligia Lanna / Collection: Instituto Alana

↑ Snake-shaped bench built with earthbag construction in a nature-based park in Mogi das Cruzes, Brazil.

EARTHBAG CONSTRUCTION WITH SOIL-CEMENT

⚠ Key points

Walls should be coated to withstand weather exposure, extending their durability.

Keep in mind that soil strength and durability can be enhanced by using appropriate stabilizing materials. Sandy soils react better with cement (in the composition known as soil-cement), while clay-rich soils respond better to lime. Recognizing the type of soil available on site is therefore essential for selecting the right stabilization method.

When raw earth walls are built without cement or lime (though sometimes finished with a lime plaster) the soil can be reused at the end of their life cycle for other purposes such as vegetable gardens, green roofs, or earthen mounds. This offers a powerful example of the cyclical logic of natural materials.

Smaller structures can be built by students with some guidance, providing a valuable opportunity for hands-on interaction within the school environment.

▲△△ **Maintenance** light

Occasional upkeep of the wall coating, when needed.

▲▲△ **Cost** low to medium

Material costs are low, but overall expenses may rise if skilled labor is needed.

EARTHBAG CONSTRUCTION WITH SOIL-CEMENT

The use of natural raw materials makes maintenance relatively easy and highlights local elements.

formwork; raffia or canvas bags and local soil with cement; lime plaster

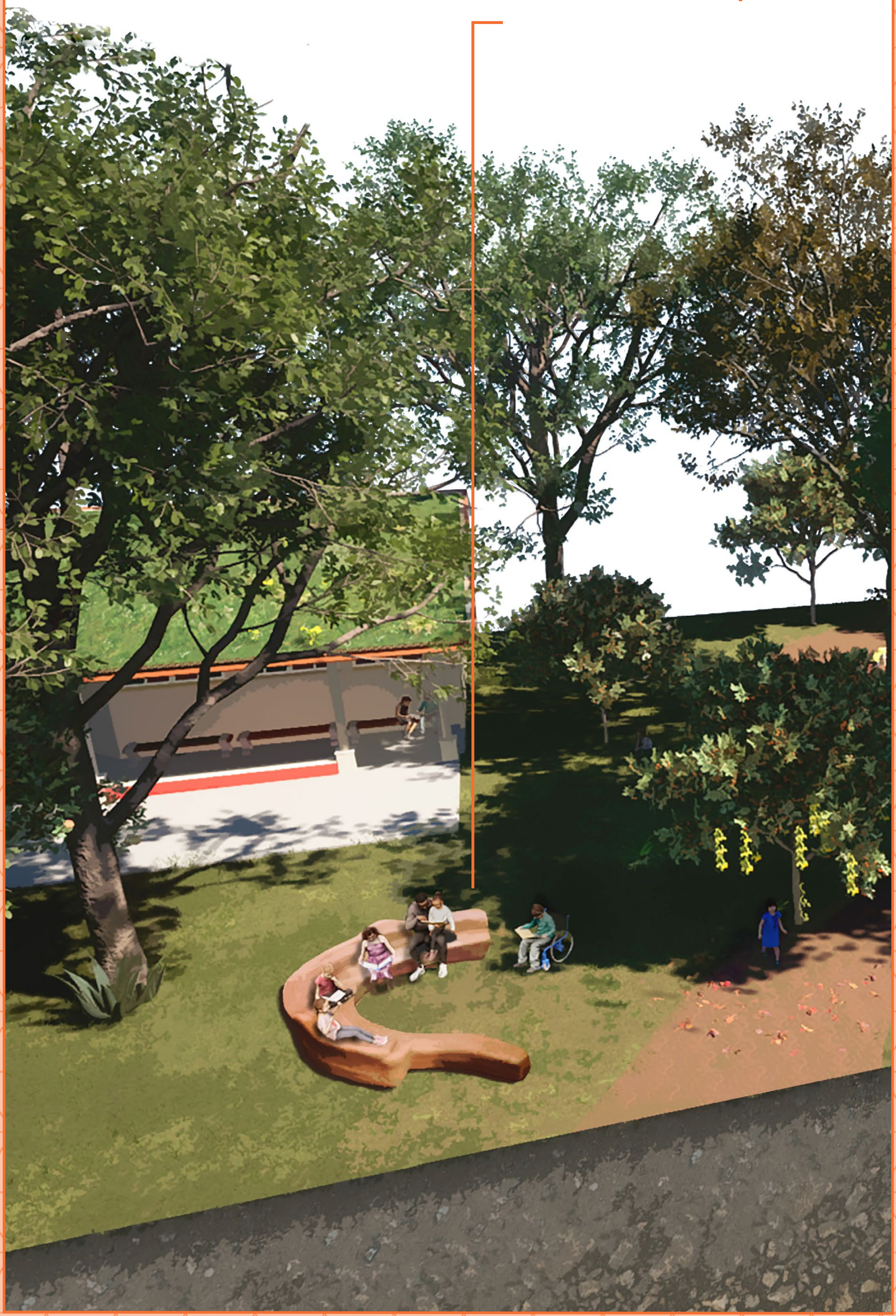


Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

D.4 Composters

This system transforms organic material into fertilizer by providing ideal conditions for decomposition.

Image: Joel Reichert / Collection: Instituto Alana

↑ **The composter at Pica-Pau Amarelo Municipal Early Childhood Education School in Novo Hamburgo, Brazil, is an excellent tool for learning about biodiversity and the process of transforming organic waste into fertilizer.**

COMPOSTERS

▲△△ **Maintenance** light

▲△△ **Cost** low

◆ **Best suited for**

Outdoor spaces.

Recreational and educational aspects

- Teaches about recycling organic waste and producing compost for gardens or vegetable beds.
- Provides hands-on lessons on the nutrient cycle.
- Encourages waste reduction and greater environmental responsibility.
- Ensures proper waste management, prompting reflection on food waste reduction and inspiring recipe books for making full use of ingredients.
- Highlights soil biodiversity and the importance of a living soil without chemical fertilizers, which harm the health of people, animals, and the environment.
- Stimulates sensory exploration through diverse perceptions.

★ Benefits of the solution

- Food security, regeneration of biodiversity, and stronger, healthier local ecosystems.
- Opportunities for learning that support high-quality climate education.

EFFECTIVE PRACTICES

Sainte Marie de Yagma School, Ouagadougou, Burkina Faso [62]

Located in an outlying area, the school began developing an agroecological garden in 2017. The project was coordinated by APAF Burkina Faso, which brought together the school administration, members of the parents' association, and the women working in the school cafeteria.[63] Parents and students joined in, beginning with the creation of a composting area. Through this process, participants learned about the value of turning organic waste into natural fertilizer to enrich the soil, while also gaining hands-on experience with organic farming techniques in preparation for establishing the garden.

D.5 Vegetable (or edible) gardens

A school vegetable garden is an opportunity to reestablish an ecosystem through biodiverse cultivation, free of chemical products, and by including plants that serve purposes beyond feeding people. Intercropping food plants with companion species helps repel certain insects or “pests” and contributes to soil health (green manure). Bringing diversity and vitality to the garden is therefore an effective strategy for maintaining ecological balance and producing healthy food. Soil care is also essential. Organic fertilizers — such as vermicompost or compost, both of which can be produced at the school — are preferred, and the soil should be kept covered with dry leaves or straw. This practice sustains a living soil ecosystem, which is fundamental for nourishing plants. The garden can also host medicinal, aromatic, and culturally significant plants.

Image: Joel Reichert / Collection: Instituto Alana

↑ Involving children in planting, maintaining, and harvesting gardens fosters learning about agriculture and encourages healthy eating, as seen at Pica-Pau Amarelo Early Childhood Education Center in Novo Hamburgo, Brazil.

VEGETABLE (OR EDIBLE) GARDENS

▲△△ **Maintenance** light

▲△△ **Cost** low

◆ **Best suited for**

Outdoor spaces.

VEGETABLE (OR EDIBLE) GARDENS

Recreational and educational aspects

- Encourages learning about sustainable agriculture, healthy eating, and natural cycles.
- Builds students' sense of responsibility for caring for plants.
- Creates opportunities for positive transformation of the environment.
- Teaches about the origin of food, including the cultural recovery of traditional cooking practices, full use of ingredients, and improved eating habits for children.
- Provides hands-on activities related to measuring quantities and studying the life cycle of plants.
- Provides sensory stimulation — including for students with visual impairments or other needs — through plants with different textures, colors, aromas, and flavors.
- Fosters understanding of the interdependence between living beings, soil, water, and climate.
- Promotes meaningful interdisciplinary learning by connecting science, math, language, geography, and arts in a practical, experiential way.

Benefits of the solution

- Food security.
- Biodiversity regeneration and the strengthening of healthy local ecosystems.
- Opportunities for learning that contribute to high-quality climate education.

EFFECTIVE PRACTICES

Un Potager au Lycée, France [64]

This program began in five schools across different cities. Landscape architects were invited to design projects that encouraged principals to engage students in reflecting on major contemporary challenges such as environmental protection, sustainable development, food self-sufficiency, and water conservation. At the same time, the initiative promoted the principles of permaculture by exploring ways to create gardens through the responsible use of space. It also aimed to build children's sense of responsibility by teaching them about food production cycles and preparation. Students took an active role in developing the gardens and adapting outdoor spaces for a variety of uses.

School Nutrition Gardens, India [65]

The Ministry of Human Resource Development (MHRD) developed this nationwide program to improve school infrastructure by introducing School Nutrition Gardens, also called Kitchen Gardens. The goal is for every child to learn how to grow their own food, connecting children and youth with natural cycles, building resilience in their diets, and reducing malnutrition in the world's most populous country. This policy also addresses the harmful effects of climate change on food availability while contributing to climate mitigation by storing carbon in the soil and reducing emissions from food transport.

Schools with limited space are encouraged to grow fruits and vegetables in pots, on rooftops or terraces, and to plant climbing species on walls, ensuring that food can be cultivated even in small areas. With guidance from teachers, students take responsibility for the entire production process.

E Slope stabilization

Nature-based Solutions (NbS) for slope stabilization play a crucial role in protecting hillsides and embankments that are vulnerable to landslides. In humid biomes, these interventions rely on native vegetation and techniques such as planting trees and creating deep-rooted gardens to stabilize the soil and reduce the risk of landslides. In more arid regions, such as savannas, slope stabilization can be achieved with drought-resistant plants that help minimize erosion and improve water infiltration, preventing soil degradation and the silting of rivers and streams.

In urban areas — especially large cities with rugged terrain — NbS for slope stabilization are vital for community safety and are often found on school grounds, particularly in schools located in favelas or other vulnerable areas. In addition to preventing natural disasters such as landslides during heavy rains, these solutions foster environmental recovery and landscape resilience. Using vegetation to stabilize slopes also helps preserve local biodiversity and improves quality of life for the people who depend on these areas for survival, while ensuring water conservation and protection against the impacts of climate change.

E.1 Stone walls with vegetation

Stone walls with vegetation combine stone structures with plantings adapted to the local climate. This solution stabilizes slopes while providing efficient drainage, reducing erosion and regulating temperatures in the surrounding area.

Local stone is used to build the base structure of the wall, ensuring stability and good drainage. Enriched soil fills the gaps between stones, supporting plant growth. Native vegetation, composed of species adapted to the local soil and climate, adds further stabilization and blends the wall into the landscape. In addition, a drainage system is incorporated to prevent water accumulation and enhance natural infiltration into the ground.

E.2 Live crib walls

Designed to stabilize slopes while integrating structural and ecological benefits, live crib walls are made from wooden frameworks and can be used on slopes up to 20 meters high and with inclines of up to 70 degrees. As the soil is filled in, strips of vegetation or seeds are inserted. Once established, the plants strengthen the structure and integrate it with the natural environment.

The wooden framework, built as single or double grids, ensures initial stability until roots are fully developed. Logs are interlocked in a “campfire” arrangement for added strength, and the grids are secured with nails, stakes, or root systems, depending on soil type and site conditions. Vegetation, composed of species adapted to the local climate, assumes the structural role once deep roots develop, creating infiltration channels for rainwater. The selection of plant species and anchoring techniques must consider factors such as climate, wind, and terrain characteristics.

Image: Paula Mendonça / Collection: Instituto Alana

↑ A terraced bed with stones and plants improves soil permeability, slows rainwater runoff, and helps prevent surface erosion.

Image: Paula Mendonça / Collection: Instituto Alana

↑ At Francisco Sá Park in Fortaleza, Brazil, the natural terrain is treated as an asset — used both to add features that foster community interaction and exploration and to implement measures that stabilize slopes and prevent landslides.

SLOPE STABILIZATION

Locally sourced stones form the wall's base structure, ensuring efficient drainage and stability. Enriched soil fills the spaces between the stones, supporting the growth of vegetation. Native plant species, adapted to the local climate and soil, provide additional stabilization and blend the structure into the surrounding landscape. In addition, a drainage system helps prevent water buildup and promotes natural infiltration into the ground.

⚠ Key points

Larger stones should be placed at the base, with smaller stones on the upper layers, to create a stable structure.

Vegetation with deep roots — preferably drought-resistant species — should be prioritized.

▲△△ **Maintenance** light

The structure should be inspected regularly to ensure its integrity, and the drainage system must be kept clear to allow water to flow freely and prevent any buildup.

▲▲△ **Cost** low to medium

Costs are low for live crib walls and potentially higher for stone walls with vegetation, depending on the scale of the intervention.

◆ Best suited for

Outdoor spaces and buildings.

Recreational and educational aspects

- Enable physical activities that challenge motor skills and encourage teamwork.
- Develop motor skills and safety awareness.
- Integrate with physical education or recreation classes.
- Support studies of water pathways and their interaction with different surfaces or land uses (infiltration, runoff, sediment transport, erosion, and siltation), while introducing the concept of a watershed.

Environmental challenges addressed

- Extreme heat.
- Localized flooding.
- Landslides.

Benefits of the solution

- Biodiversity regeneration and stronger, healthier local ecosystems.
- Opportunities for learning that support high-quality climate education.
- Improved learning environment and overall well-being.

SLOPE STABILIZATION

A slope stabilization strategy can also serve as an opportunity to incorporate elements for play and learning.

structural wood (single or double grids)

site-appropriate vegetation

slide

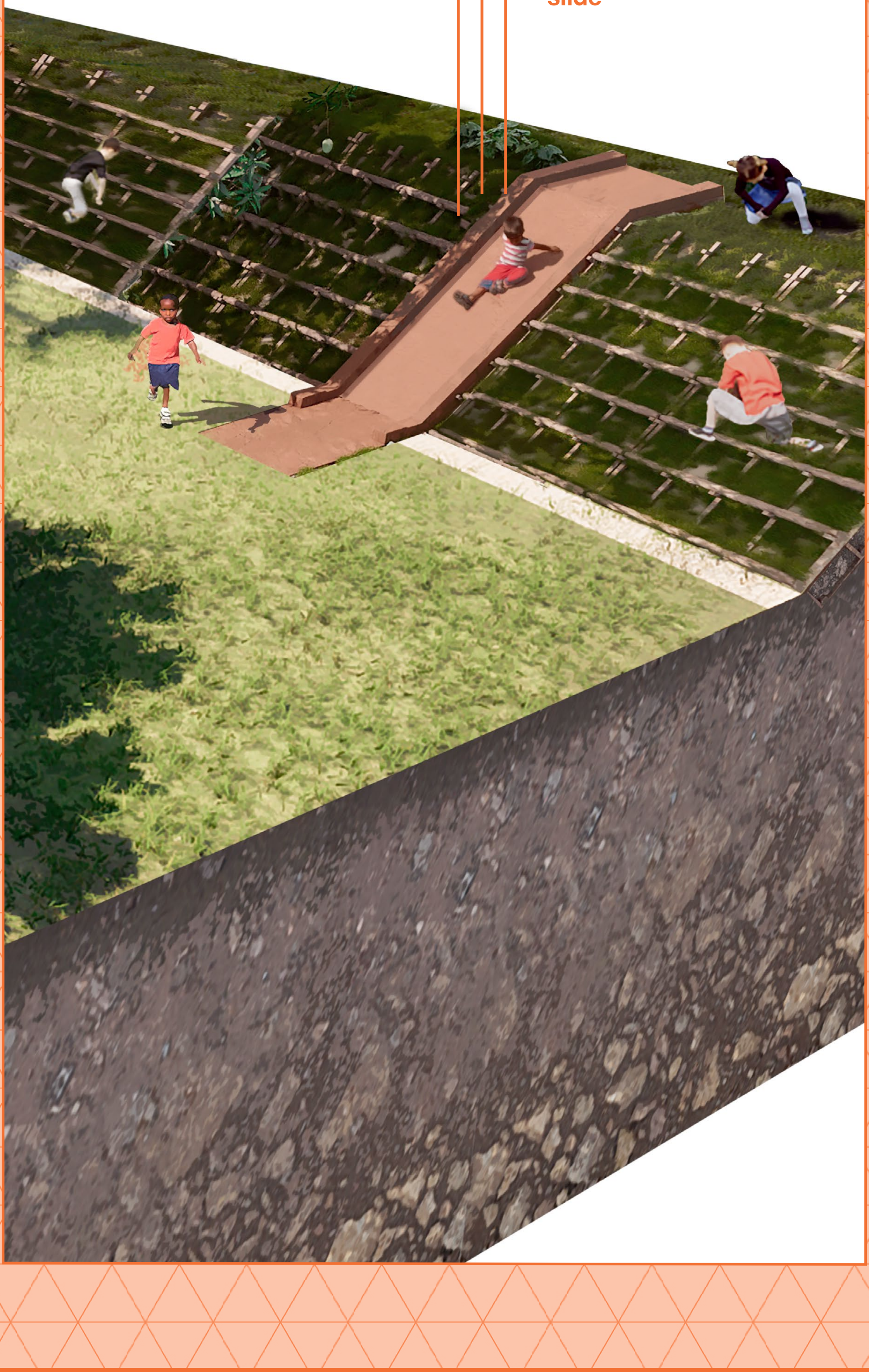


Image: Guajava Arquitetura da Paisagem e Urbanismo / Collection: Instituto Alana

2.4 Project approval

So far, we have outlined a range of possibilities that can be adapted to different school settings, depending on space, infrastructure, biome, and climate conditions. These options provide the foundation for designing projects that make schools more resilient to climate change. Once a project is designed, **the school community is brought back in to review and validate proposals**. This participatory step ensures the project reflects community needs and aspirations, allows for joint adjustments suited to the local context, and helps sustain relationships and align expectations.

③ Implementation

3.1 Preparation for construction

With detailed plans approved by the school community and relevant authorities, implementation can begin. It is essential to choose a construction team with knowledge and technical experience in nature-based adaptations. Whenever possible, local labor and locally sourced materials, especially native plant species, should be used.

Image: Tibico Brasil / Collection: Instituto Alana

↑ **Community members take part in a community clean-up and planting at Francisco Sá Park in Fortaleza, Brazil. Their participation strengthens social bonds and a sense of belonging, creating a welcoming and engaging environment for the care and preservation of the space.**

The work area should be secured and construction scheduled to take place during school breaks, regardless of the project's scale. This helps minimize disruptions from noise, debris, the handling of materials, and the movement of people. The entire school community should be informed of the schedule and any measures that might affect daily routines, with communication kept clear and accessible. The committee formed during the planning stage can take responsibility for answering questions and ensuring information is shared effectively.

3.2 School community participation

Nature-based Solutions (NbS) involve different implementation processes and materials, yet many share a common feature: they are built in partnership with the community. Inviting students, caregivers, staff, and local stakeholders to take part throughout the phases of development fosters shared ownership and connection to the space, expands both technical and practical knowledge, and strengthens long-term sustainability for the care and maintenance of these solutions.

It is also recommended that the technical team contracted to implement NbS and other solutions provide training and/or develop a system with the school community and committee for evaluating and main-

taining the adapted spaces. This includes establishing verification criteria to ensure spaces are being used, shaped, and programmed in ways that are appropriate to local needs.

3.3 Inauguration

Hosting a launch event is a lively way to share the ideas and processes behind adapting school spaces through NbS. It helps unite the community and reinforces a sense of shared ownership. This is also a moment to celebrate with everyone who participated in the process and to broaden the network by inviting other local sectors and groups, such as health clinics, cultural institutions, and community associations.

Image: Elvis Edson / Collection: Prefeitura de Caruaru

↑ At the inauguration of the Lindaura Severina nature-based park in Caruaru, Brazil, the city invited the local cultural group Boi Tira-Teima to take part, bringing cultural elements and a sense of belonging to the opening of the public space.

④ Care and protection

Once construction is complete and the space inaugurated, the new areas will become part of the school's daily life, supporting learning, movement, play, sports, socializing, rest, and recreation. As with any physical space, whether greened or not, ongoing conservation and regular maintenance are necessary. This is not unique to nature-based spaces.

For public schools, it is the responsibility of public authorities to provide specialized maintenance and allocate financial resources for these needs. Establishing a shared schedule and monitoring tools with the school administration and committee can make it easier to plan these activities and ensure the infrastructure is kept in good condition.

Using local labor, materials, and native vegetation helps reduce costs and ensure access to needed supplies. The community and school committee can also be invited to join collective efforts for planting, watering, harvesting, pruning, and material replacement. Incorporating these activities into teaching practices further enriches students' experiences with sustainable solutions and strengthens their connection to nature and school spaces.

Posting banners or signs in common areas with information about the features of the NbS in place and how to care for them makes knowledge more accessible and helps spread maintenance practices. Children play a key role at this stage. In addition to being active agents of change, students can model and share good practices, particularly as they move up through the grades, passing knowledge along to younger peers who were not part of the original training and construction process.

After the adapted school spaces have been in use for several months, it is advisable to conduct a survey on how greening the infrastructure has affected teaching practices and the overall school environment. The findings can help spread and replicate adaptation strategies in other schools, highlighting the positive changes observed. Below are some guiding questions to shape the survey and better understand the impact of these adaptations:

- Have there been changes in children's behavior?

- Have there been changes in the condition of the spaces on rainy days?

- Have there been changes in the temperature and comfort of outdoor spaces?

- Have there been changes in the temperature and comfort of indoor spaces?

- Has the school's curriculum changed following the adaptation of school spaces?

- Does your school's curriculum include suggestions for activities with and in nature?

- Since the greening of school spaces, has there been any change in how often organic materials (soil, sand, clay, water, flowers, leaves, etc.) are used?

- Have the activities listed above become more frequent?

Image: Felipe Corrêa / Collection: Instituto Alana

↑ Member of the Boi Tira-Teima cultural group at the inauguration of the Lindaura Severina nature-based park in Caruaru, Brazil.

5. International resources for school infrastructure

CODINA, Joaquim José. [Anthurium], n.d. Drawing, watercolor, 26.5 × 17cm.

School infrastructure is a critical part of education quality. It requires ongoing investment in safe, accessible, and welcoming spaces that support learning, inclusion, equity, and student retention.

Integrating green areas and Nature-based Solutions (NbS) into school infrastructure is not only an adaptive response to extreme climate events. It is also a strategic way to enhance the learning environment and foster children's overall development. For this reason, every school — whether or not it faces extreme weather — should include green areas as part of an infrastructure that supports quality education.

It is essential to recognize that the impacts of the climate crisis and poor infrastructure are not distributed equally. Communities that have been historically marginalized — often marked by racial, territorial, and socioeconomic inequalities — face greater socio-environmental challenges and should be prioritized in the allocation of resources and the implementation of NbS. Advancing environmental justice in education means ensuring that these populations have access to safe, green, and healthy school environments as part of their right to both education and place.

Collection: Instituto Alana

↑ At Virgílio de Mello Franco Municipal Elementary School in São Paulo, Brazil, the participation of the school community was essential for identifying needs and setting priorities for the use of resources.

Budgeting and financial planning

Planning is a vital tool for transforming school infrastructure. It helps identify needs, set priorities, estimate costs, secure funding, and organize implementation. For school administrators, planning also makes it possible to pinpoint underserved areas, decide which schools should be built, renovated, or expanded, and reorganize the school network as needed.

This process typically follows five main steps: i) conducting a needs assessment, ii) defining objectives, goals, and strategies, iii) developing projects, programs, and policies, iv) monitoring progress, and v) evaluating implementation.

LEARN MORE

Diagnosis as the first step in planning

Conducting a detailed assessment of school infrastructure is the first essential step toward effective budgetary and financial planning. This assessment should cover not only the physical conditions of the school — such as the state of building maintenance, accessibility, presence of green areas, natural lighting, and ventilation — but also administrative, pedagogical, financial, and legal aspects. The analysis should also take into account the availability of updated architectural plans (such as floor plans and electrical and plumbing systems) and identify specific needs related to climate adaptation and the use of Nature-based Solutions (NbS). A well-executed assessment guides the setting of priorities, ensures efficient allocation of resources, facilitates access to funding, and strengthens democratic and participatory school governance.

① Defining objectives, targets, and strategies

This step identifies what is to be achieved (objectives), sets specific quantities and timelines (targets), and determines how those targets will be reached (strategies).

TIP When defining objectives, make sure they are clear and measurable.

OBJECTIVES	The intended achievements	Example: Adapt school infrastructure to the climate changes projected for the municipality by the relevant regional authorities.
TARGETS	The defined scope and timeframe of the intended achievements	Example: Introduce Nature-based Solutions (NbS) in the outdoor areas of large schools, tailored to the local context and potential challenges.
STRATEGIES	Planned approaches for reaching the targets	Example: Invest in upgrading outdoor school infrastructure through specific projects, prioritizing schools in high-risk and more vulnerable areas, based on data from the agency responsible for regional climate impact forecasts.

② Developing projects, programs, and policies

Based on the objectives and strategies, organizations develop structured actions (projects and programs) and guiding frameworks (policies) to direct the use of resources.

PROJECTS	Time-bound actions designed to achieve specific outcomes	Example: Adapted School Project, focused on greening outdoor spaces
PROGRAMS	A collection of related projects that share a common goal	Example: School Infrastructure Adaptation Program
POLICIES	Broad, ongoing directives that provide a framework for programs	Example: Municipal Green School Infrastructure Policy

③ Estimating costs and allocating resources

- Estimate the costs for each action.
- Allocate financial, human, and material resources based on the priority of each project or program.
- Make sure the budget is realistic and feasible, and include a safety margin for unforeseen expenses.

④ Implementation

- Launch projects according to the planned schedule.
- Set clear performance indicators to track progress, supported by regular oversight meetings.

⑤ Monitoring and evaluation

Well-defined indicators are essential for assessing whether the plan's objectives and targets are being met. They help track performance over time, highlight progress and challenges, and inform decisions about necessary adjustments. Indicators should reflect local conditions and remain aligned with the established objectives. Collected data must also be organized and shared with school leadership teams and the broader school community, reinforcing transparency and shared responsibility.

MONITORING	Regularly track the progress of activities and the use of resources, and compile all reports from the implementtion phase.
EVALUATION	At the end of each cycle (semester or year), assess whether the objectives and targets were met, and use the results to identify improvements and guide new actions.

SUMMARY OF STEPS

STEP	WHAT TO DO	HOW TO DO IT
Define objectives, targets, and strategies.	Clarify what you want to achieve.	Set explicit targets and practical strategies.
Develop projects, programs, and policies.	Plan how to act.	Create organized actions with defined timelines, roles, and responsibilities.
Estimate costs and allocate resources.	Plan the budget.	Identify costs and prioritize investments to promote equity and socio-environmental justice.
Implement.	Put the plan into practice.	Track progress with performance indicators.
Monitor and evaluate.	Review results.	Make adjustments to improve performance.

> **To comply with all accountability requirements and meet legal deadlines and regulations, it is essential to organize documentation such as invoices, procurement records, public notices, contracts, and reports. This process helps ensure transparency, strengthen internal and external controls, and support the monitoring and evaluation of educational initiatives.**

Resources for resilient school infrastructure

UNESCO

UNESCO offers a toolbox to help schools build safe, high-quality facilities.[66] The goal is to give countries a solid foundation for public policies that ensure suitable conditions and equal opportunities for all students. Infrastructure is not just technical support — it is a vital part of delivering socially equitable education.

World Bank

In 2014, the World Bank launched the Global Program for Safer Schools (GPSS),[67] supported by the Global Facility for Disaster Reduction and Recovery (GFDRR). The program builds on earlier financing efforts in Colombia, the Philippines, and Turkey. Its purpose is to expand investments that strengthen school infrastructure against natural and climate-related disasters, reducing risks while improving the quality of learning environments.

The GPSS aims to promote:

- Comprehensive planning, ensuring not only high-quality school facilities but also improvements in air and water quality, sanitation, and energy efficiency.
- Prioritizing vulnerable children, maximizing the benefits of interventions by focusing on risks that affect those most exposed, with goals that promote safety for all.
- Improved engineering solutions through modeling and construction technologies that make large-scale school renovations both affordable and scalable.
- Mobilization of financial resources to support governments in their efforts.

International Finance Facility for Education

The International Finance Facility for Education (IFFEd) is a public–philanthropic partnership that finances public schools to improve education and training for children and young people in lower-middle-income countries (LMICs).[68] Funding comes from multilateral development banks, expanded through grants and sovereign guarantees to increase resources for hu-

man development, including school infrastructure.[69] The initiative aims to reach half of the world's children and young people — over 1.2 billion students — in the most economically and socially vulnerable countries.

Creating school infrastructure that is green, accessible, and welcoming requires strategic planning, collective effort, and a strong commitment to the right to quality education. Each school that becomes a safe space with access to nature reaffirms the right of children — even in the face of present and future threats — to imagine, dream, and build a better world.

Image: Tibico Brasil / Collection: Instituto Alana

↑ João Hildo de Carvalho I Early Childhood Education Center, Fortaleza, Brazil. Schoolyard renovation can incorporate resilience-focused resources and draw on partnerships with other municipal sectors, such as the department of environment, to provide tree prunings and seedlings.

6. Final considerations

CODINA, Joaquim José. [Aroidea], n.d. Drawing, watercolor, 26.5 × 17 cm.

Throughout this guide, we have sought to show that transforming schools into greener, more resilient spaces is not only a necessary response to the climate crisis, but also a powerful opportunity to improve education, promote the well-being of the school community, and strengthen children's connection with nature. Now it is up to you — administrators, principals, educators, and entire school communities — to bring this movement to life!

Implementing **Nature-based Solutions (NbS)** has proven to be an effective and practical response to the urgent socio-environmental crises we face. There is no time to waste: action is needed now, with care, accountability, and the right tools. This means reimagining schools as living spaces where teaching, learning, play, and care for the world go hand in hand. When these solutions take shape in schoolyards and connect with the wider community, they not only restore the environment but also awaken experiences, knowledge, and practices that students carry throughout their lives. These experiences teach care for oneself, for others, and for the planet — and for that reason, they are indispensable in school curricula.

We invite you to lead this transformation — not as a solitary task, but as part of a broader social pact: a pact for environmental and climate regeneration, for the right to a healthy life, for childhood, for climate

justice, for education, and for a habitable world for humanity and all forms of life.

This guide is both a call to action and a source of inspiration. Changes that begin within schools have the power to reach far beyond their walls. Greener schools enhance their surroundings, mobilize communities, and can serve as models for healthier, more inclusive, and more sustainable neighborhoods and cities. When nature once again becomes part of daily school life, it also returns to community and city life.

This is not only about transforming school infrastructure, but about fostering a deep cultural shift — to one that values local and traditional knowledge, especially that of Indigenous Peoples and Traditional Communities; that encourages the active participation of everyone in the school community; and that sees the bond with nature as fundamental to the formation of citizens who are committed to the sociobiodiversity* that sustains life on Earth.

It also means ensuring that our children are prepared to face the challenges of the 21st century with sensitivity, critical thinking, creativity, and resilience,

[EXPLANATORY NOTE] * Sociobiodiversity describes the range of living forms linked to the cultures, knowledge, practices, and ways of life of Traditional Peoples and Communities, underscoring the interdependence of biological and sociocultural diversity.

supported by concrete strategies and tools that strengthen their capacity to understand, demand change, take action, and transform the contexts in which they live.

Start with what is possible, mobilize your network, share experiences, and adapt to your reality. Every action matters. May this guide serve as a starting point, and may transformation flourish in every school, neighborhood, city, and country of our shared world.

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Alana is a socio-environmental impact ecosystem committed to improving the lives of children in Brazil and around the world. It works on multiple fronts — education, science, entertainment, and advocacy — to uphold children's rights and to shape public and cultural policies that affect children's lives today and in the future. The ecosystem brings together Instituto Alana, the Alana Foundation, and Maria Farinha Filmes. Their initiatives range from producing scientific research to creating campaigns and cultural content, alongside political advocacy and legal action. Each organization works in close connection with the others, united by the goal of building a fairer, more sustainable, and more inclusive society for children.

alana.org.br

Escola+Natureza is a movement to adapt school spaces to a changing climate and to reconnect children with the natural world.

Schools play a central role in both reconnecting children and adolescents with nature and advancing climate action. That is why we offer inspiration, information, and practical tools to help transform schools — so that every child and adolescent has daily access to nature, educators can adopt new pedagogical practices, and school spaces become greener and more resilient to the climate crisis.

Playing and learning in nature and open spaces are vital for the physical and mental health of children and adolescents, as well as for their overall development. For many, school may be the only place where this is possible. At the same time, with the climate already altered, it is essential to identify schools most vulnerable to heat waves, localized flooding, major floods, and landslides — and to take action to reduce risks and build resilience.

To ensure this transformation is lasting and widespread, we pursue solutions that extend beyond infrastructure alone:

- **School (facilities and operations):** Breaking up concrete, planting native vegetation, and adopting Nature-based Solutions — such as rain gardens, composting, and water collection and treatment — to transform spaces and make them more resilient.

- **Curriculum:** Using outdoor spaces for pedagogical purposes, promoting *desemparedamento* (taking learning beyond walls) for children and adolescents, and fostering their connection with nature and engagement in its conservation.

- **Community:** Creating solutions for the areas surrounding schools so that everyone has access to a green space within 500 meters — for example, prioritizing these locations for the creation of parks and plazas.

- **City:** Integrating schools into environmental and urban planning, with a focus on risk prevention and reduction, regeneration, and adaptation to climate change — always beginning with schools and their communities, and prioritizing the most vulnerable spaces and populations.

The **Fundo Nacional de Desenvolvimento da Educação (National Fund for Educational Development) (FNDE)** is a federal agency established by Law No. 5.537/1968 and linked to the Brazilian Ministry of Education. Its mission is to provide technical and financial assistance and to implement programs and initiatives that ensure quality education for all.

The FNDE administers a range of programs, including the Programa Dinheiro Direto na Escola (Direct School Funding Program) (PDDE), Programa Nacional de Alimentação Escolar (National School Nutrition Program) (PNAE), Programa Nacional do Livro Didático (National Textbook Program) (PNLD), school transportation, Proinfância, and others. It is also responsible for the construction, renovation, and maintenance of public school infrastructure, and for the purchase of furniture and equipment.

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Nature-based Education
A guide for greener and more resilient schools

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How can Brazilian schools prepare for the climate crisis?

According to UNICEF, in 2024 at least 242 million students — from preschool through high school — in 85 countries saw their education disrupted by extreme weather. Adapting school environments to these effects is no longer optional; it is urgent. Floods, heat waves, landslides, and droughts threaten the right to education, harm the health of children, adolescents, and educators, and reveal how vulnerable school communities are in the face of extreme events.

This guide aims to help schools adapt based on a simple idea: treating Nature as a partner in education. Building on the concept of Nature-based Education (NbE) and various Nature-based Solutions (NbS), it provides clear, practical ways to make schools greener, safer, healthier, and more resilient.

This publication is intended for school administrators, technical teams in education and public works, and anyone committed to quality education. It outlines strategies to renew school environments, reduce the impacts of climate change, and foster learning that is rooted in place, connected to diverse knowledge systems, and grounded in social and environmental justice.

Preparing schools for the climate emergency means protecting childhood, upholding rights, and nurturing a livable present and future.

This is an urgent call to act now.

Production

Institutional Support