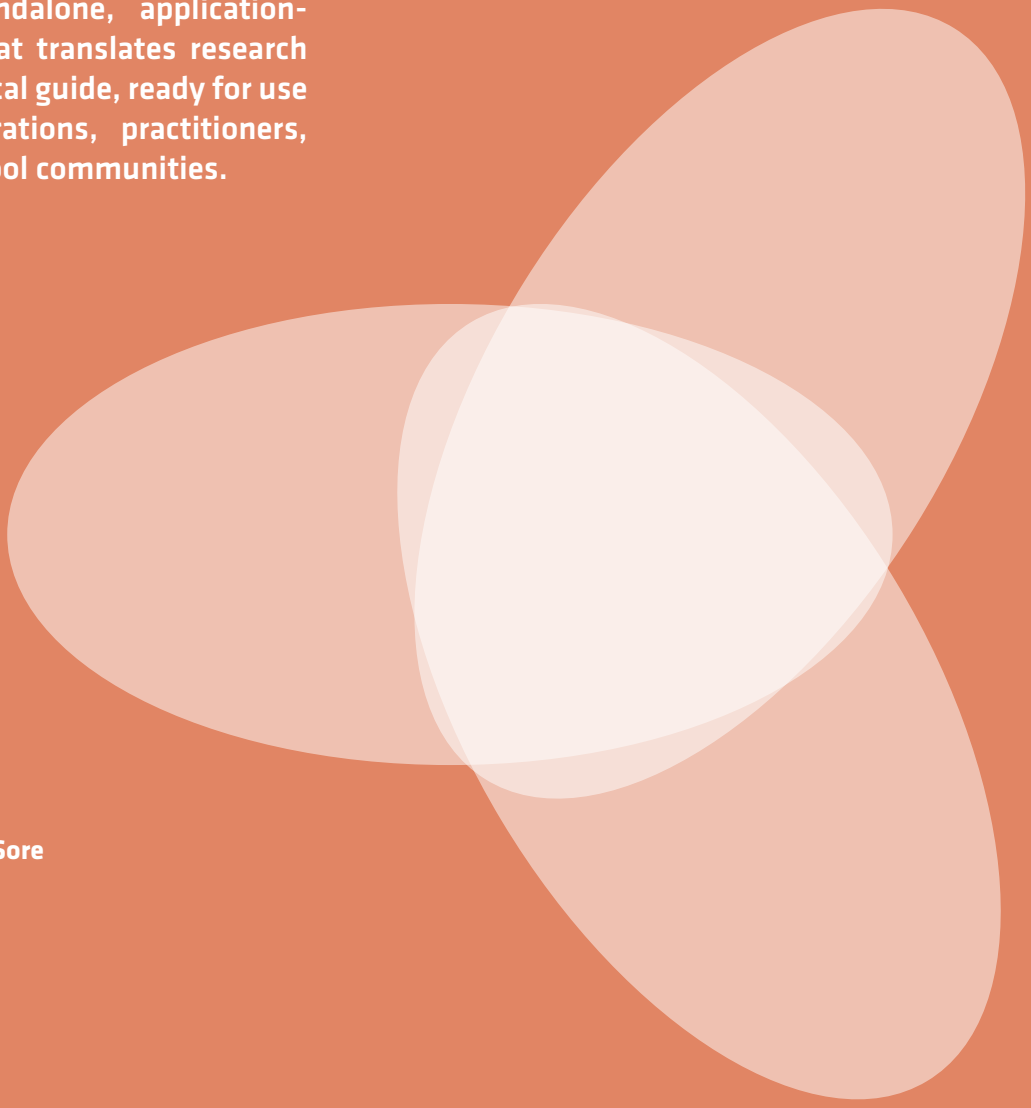
UNIVERSITÀ DEGLI STUDI FIRENZE

Da un secolo, oltre.

REACTIVE Toolkit

Annex

The annex presents the final output of the research: the REACTIVE Toolkit. It is designed as a standalone, application-oriented resource that translates research findings into a practical guide, ready for use by public administrations, practitioners, researchers, and school communities.



PhD Candidate: Antonia Sore

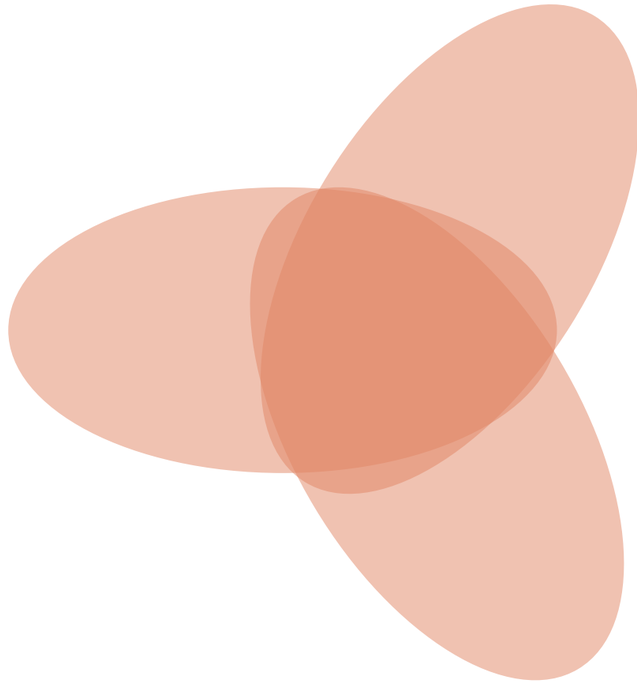
Tutor: Prof. Rosa Romano

Forward

In an era of rising climate challenges and growing urban health concerns, schools hold untapped potential to become catalysts for resilient, inclusive, and vibrant communities. The REACTIVE Framework offers a practical, science-based methodology and toolkit for transforming schoolyards and school-related micro-urban spaces into climate-resilient, health-promoting, and activity-rich environments.

Designed for architects, urban planners, educators, and policymakers, this guide provides a clear process, assessment tools, design strategies, and co-design tools to support transformation at every scale –from single schoolyards to city-wide programs.

Rooted in systemic thinking and built on the review of scientific and grey literature, as well as real-world applications, the REACTIVE Framework bridges the gap between research and practice, offering actionable pathways for reimagining school-related micro-urban spaces as living infrastructures for learning, health, and climate adaptation.



Executive Summary

THE REACTIVE Framework and Toolkit comprises a conceptual framework, a practical methodology, and a modular set of tools to support the climate-adaptive transformation of schoolyards into healthy, inclusive, and development-supportive environments.

The framework defines the conceptual foundation. It identifies the desired outcomes (health and child development), the key determinants (e.g., thermal comfort, water management, biodiversity), and the spatial scales of analysis (neighbourhood level, school premises and thresholds, schoolyard).

The framework is applied in practice through three phases and a continuous validation loop. The process is iterative and cab be adaptable to context, user needs, and scale. The phases include:

Phase 1 – Understand & Explore: risk, exposure, and vulnerability analysis; needs assessment
Phase 2 – Set Goals, Priorities & Response Options: define objectives and KPIs aligned with users, policies, and evidence
Phase 3 – Design & Implement Responses: apply adaptive, inclusive, and nature-based strategies
Continuous Validation Loop – Monitor, Evaluate & Adjust: track performance and support learning and iteration

The toolkit provides a versatile set of tools that can be applied across different phases and by diverse users (e.g., municipalities, designers, school communities), including:

- REACTIVE Audit system (macro-meso-micro scale)
- Risk driver cards
- Child development & Vulnerability cards
- Co-design kit
- Design Guidelines

>>> REACTIVE is a decision-support system that links risk components hazard-exposure-vulnerability to modifiable spatial design levers across three scales.

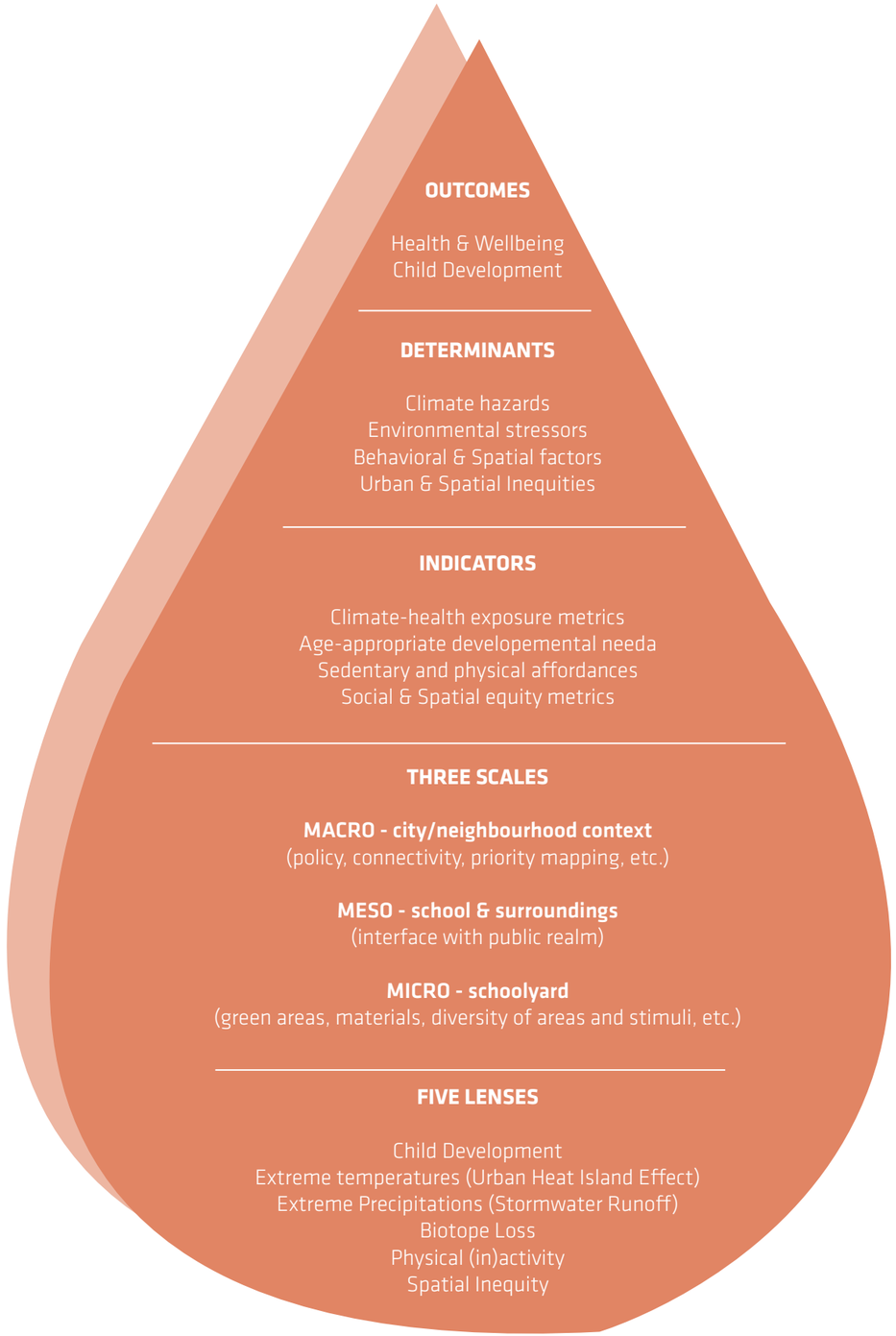


Figure 1. Framework Overview: Outcomes, Determinants, Indicators, Scales & Lenses

TOC

PART 1 –

REACTIVE Toolkit.

Why REACTIVE Toolkit?

Cities across the world are increasingly exposed to climate-related hazards such as rising temperatures, intensified rainfall, and droughts. In dense urban contexts, these hazards interact with other environmental stressors, creating compound risks for health and well-being. These risks disproportionately affect children, whose physiological, cognitive, and emotional development makes them more vulnerable to adverse environmental conditions than adults.

Research shows that children are particularly sensitive to climate-related hazards, especially heat, and to environmental stressors, as they:

- have developing organs and systems that are more sensitive to environmental exposure;
- regulate body temperature less efficiently, increasing susceptibility to heat stress;
- have higher metabolic rates and produce more body heat during physical activity;
- are more exposed to pollutants due to higher air intake relative to body weight and proximity to the ground;
- depend on outdoor movement, play, and contact with nature for healthy physical, cognitive, and social development.

These vulnerabilities extend beyond physical health. Environmental stressors such as heat, noise, and lack of access to nature are increasingly associated with mental health outcomes, including stress, reduced attention, and emotional fatigue, particularly in children. Environmental exposures experienced in childhood can also accumulate over time, shaping health trajectories across the life course.

Therefore, reducing exposure to environmental stressors and creating health-supportive environments for children is not only a matter of immediate protection, but a long-term investment in intergenerational health and resilience.

In dense urban environmnets, where quality public space is scarce, schoolyards represent one of the most widespread yet underused public resources available to children. They are large open spaces accessed daily by children, embedded within neighbourhoods, and managed by public institutions. Despite their potential to provide environmental, social, and developmental benefits, many schoolyards remain paved, poorly shaded, and ecologically simplified, reflecting outdated priorities.

By positioning school-related environments at the intersection of urban planning, public health, and climate adaptation, the REACTIVE Framework seeks to transform monofunctional schoolyards and school-related micro-urban spaces that shape children's everyday experiences into multifunctional, inclusive, and climate-resilient spaces that support children's development and strengthen urban resilience.

YOU ARE...

PUBLIC AUTHORITY

Use the REACTIVE Audits to compare schools and/or neighbourhoods with the same indicators, and prioritise interventions.

Use the co-design kit and design guideline to translate priorities into fundable actions and align them with broader climate and health strategies.

EDUCATOR

Use the toolkit to understand how space affects comfort, development, and daily routines, and to structure a simple improvement plan around priorities.

Use the co-design kit to engage students and staff, build shared ownership, and embed changes into school culture and learning activities.

URBAN DESIGNER and/or ARCHITECT

Start with the multi-scale audit (macro–meso–micro) to identify key constraints and opportunities on routes, thresholds, and schoolyard spaces.

Use the design guidelines to develop evidence-based, child-centred design moves and validate design decisions with measurable indicators.

RESEARCHER and/or STUDENT

Use the framework as a structured research method: select indicators, apply the audit templates, and collect comparable data across cases.

Use the toolkit to translate literature into spatial criteria and testable hypotheses, supporting evaluation, monitoring, and replication.

What this Toolkit helps you do?

The REACTIVE Toolkit is a practical, evidence-based set of tools and strategies designed to support the transformation of schoolyards and school-related micro-urban spaces into climate-adaptive, health-promoting, and inclusive environments.

Developed as part of a broader framework rooted in climate science, child development, and urban health, the Toolkit offers actionable resources for:

- assessing existing conditions,
- identifying needs and priorities of vulnerable groups,
- designing and implementing targeted interventions,
- rvaluating and monitoring their effectiveness.

The Toolkit is designed to serve a diverse group of users involved in planning, designing, managing, and advocating for healthier school environments. Each group can engage with the Toolkit based on its role, mandate, and goal. The toolkit does not replace local plans, technical norms, or professional judgement nor prescribe one-size-fits-all solutions. Its main intent is to guide and support whilst raising awareness on important factors shaping everyday experience and health.

Users	Toolkit Value & Application
Public Authorities & Planners	Supports policy development, intervention prioritization, and integration into broader climate and health strategies. Includes Audit tools for city-scale assessment.
Urban Designers & Architects	Provides spatial indicators, design guidelines, and solution catalogues tailored to school environments. Supports evidence-based and child-centered design.
Researcher & Students	Supports research, teaching, and thesis projects by offering a structured framework, comparable indicators, and multi-scale audit templates. Enables case-study replication across sites, supports data collection for evaluation and monitoring, and helps translate literature into spatial criteria, metrics, and design hypotheses for testing.
School Staff & Educators	Offers tools for engaging students in participatory processes, understanding the developmental impact of space, and integrating changes into school culture. Co-design kit can be used as educational and raising awareness tool.
Parents & Communities	Empowers families and local stakeholders to participate in co-design, advocate for change, and help monitor and maintain transformed spaces.

Risk logic

To translate climate and environmental challenges into actionable spatial design strategies, REACTIVE adopts a risk-based approach grounded in the IPCC logic of hazard, exposure, and vulnerability.
Within REACTIVE, risk is understood as the potential for adverse consequences for children's health, well-being, and development, arising from the interaction between:

hazards (further refered to as **risk drivers**) refer to climate, environment, and behaviour-related risk drivers that may negatively affect children's health and well-being. Within REACTIVE, these include:

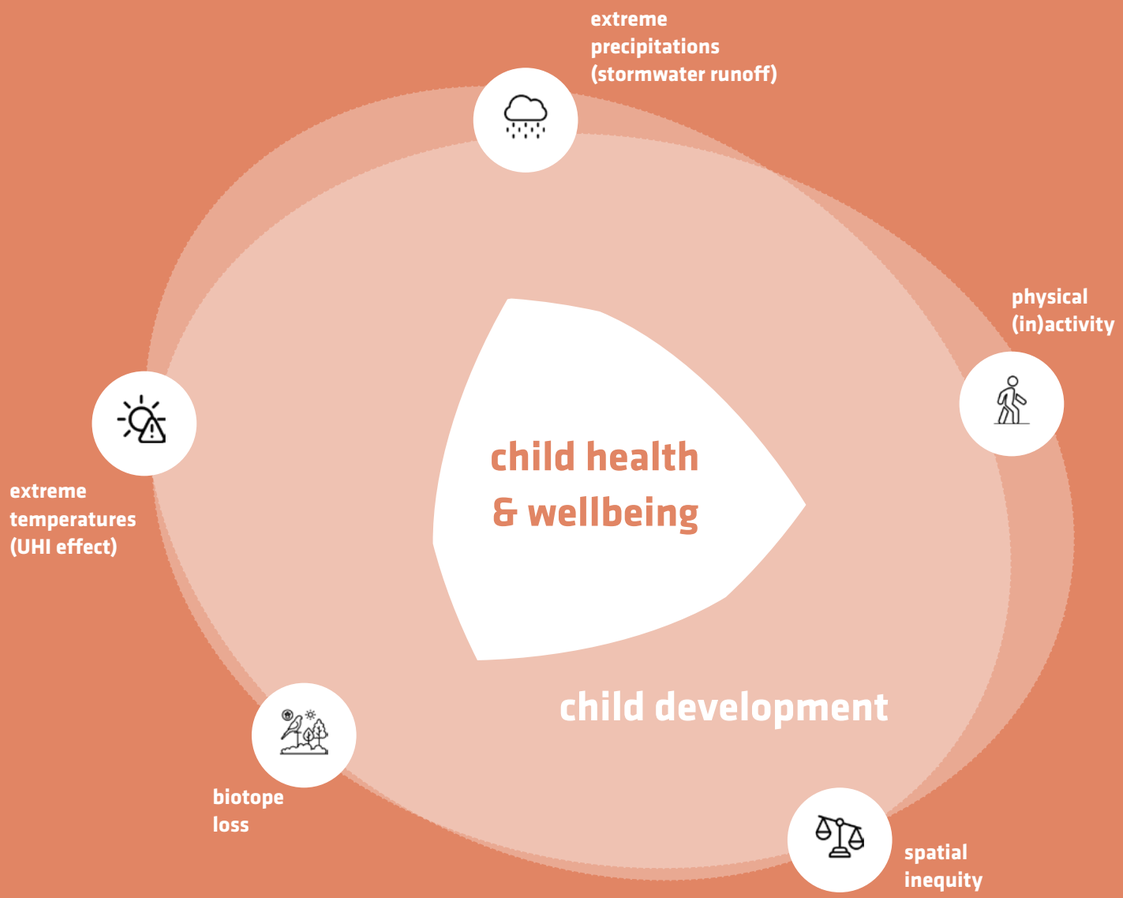
- Extreme temperatures (Urban Heat Island effect)
- Extreme precipitation (Stormwater Runoff)
- Biotope loss
- Physical (in)activity
- Spatial inequity

vulnerability refers to children's susceptibility to harm and their capacity to cope or adapt, shaped by physiological, developmental, behavioural, and spatially mediated social factors.

exposure describes how, where, and for how long children encounter hazards in their daily environments. Exposure is strongly shaped by spatial configuration and use patterns, including:

- time spent outdoors;
- location and orientation of schoolyards and play spaces;
- daily mobility routes to and from school;
- microclimatic conditions at child height.

While the IPCC risk framework explains how risk emerges from the interaction between hazard, exposure, and vulnerability, it does not prescribe how spatial design should respond. The REACTIVE Framework addresses this gap by treating these components as interrelated drivers of risk and translating them into a clear design logic. This logic is structured through guiding principles, thematic lenses, and spatial scales, and is operationalised through design strategies, audits, and evaluation tools that support systematic analysis, informed decision-making, and the assessment of whether spatial interventions effectively reduce risk and strengthen adaptive capacity across school-related environments.



REACTIVE Principles

Climate change and environmental degradation increasingly threaten children's health in urban environments. Heat stress, flooding, biodiversity loss, physical inactivity, and spatial inequity act as interconnected risk drivers that are experienced daily through the built environment. The REACTIVE Framework responds to this challenge by translating health and development research into spatial design logic. By identifying key health drivers, evaluating how they manifest across school-related environments, and linking them to modifiable spatial factors, the framework enables architects and public actors to actively reduce health risks and support healthy child development through design.
Three principles

The framework is designed around three key principles, each of which plays a crucial role in shaping the overall approach:

1. **Health as the Goal**
The primary objective of the framework is to reduce possible adverse impacts of climate hazards and environmental stressors on child health, understood as physical, mental, and social well-being.

2. **Environmental and Behavioural Determinants as Design Levers**
The health is shaped and determined by climate, environmental and behaviour drivers operationalised through five thematic design lenses that translate abstract health drivers into actionable spatial parameters.

3. **Child Development as the Guiding Interpretive and Design Lens**
Child development functions as the core interpretive lens of the framework. It shapes how hazards, exposure, and vulnerability are understood, and determines which spatial qualities are prioritised at different ages and stages of development.

REACTIVE lenses

The framework is structured around one guiding interpretative lens and five risk-driver/design lenses that represent key environmental, behavioural, and spatial determinants of health.

Guiding lens
- Child Development: the interpretive lens that shapes priorities across ages and abilities.

Risk-driver lenses (5)
- Extreme Heat & Urban Heat Island Effect
- Extreme Precipitation & Stormwater Runoff
- Biotope Loss
- Physical Inactivity
- Spatial Inequity & Accessibility

Together, these lenses create the analytical backbone of the framework and guide the analysis, design, and implementation of the built environment.

Child Development is the primary interpretive lens through which all design choices are made. Developmental stages define children's cognitive, emotional, sensory, and motor needs. At the same time, age-related physiological and behavioural characteristics determine children's vulnerability to environmental stressors such as heat exposure, air pollution, and noise thereby directly affecting the level of health risk associated with a given environment.

Climate Resilience (extreme temperatures and stormwater runoff) lens addresses climate-related hazards and focuses on the capacity of the environment to reduce climate stress through spatial design, material choices, and Nature-based Solutions, thereby reducing exposure and health risks.

Biotope lens focuses on the ecological quality of school-related environments and their capacity to support biodiversity, ecosystem functions, climate regulation, and restorative experiences.

Physical Activity lens examines how spatial design enables or constrains everyday movement, play, and active behaviours. It addresses both structured and unstructured physical activity, with attention to age, gender, and ability, recognising physical activity as a key determinant of physical health, social interaction, and emotional development.

Spatial Inequity & Accessibility lens addresses how spatial configurations and characteristics distribute environmental risks and opportunities unevenly across users. It focuses on accessibility, inclusivity, and the equitable provision of safe, healthy, and climate-resilient spaces. Spatial inequity also plays a key role in shaping children's exposure and vulnerability to environmental stressors, thereby reinforcing or mitigating health risks.

REACTIVE spatial scales scales

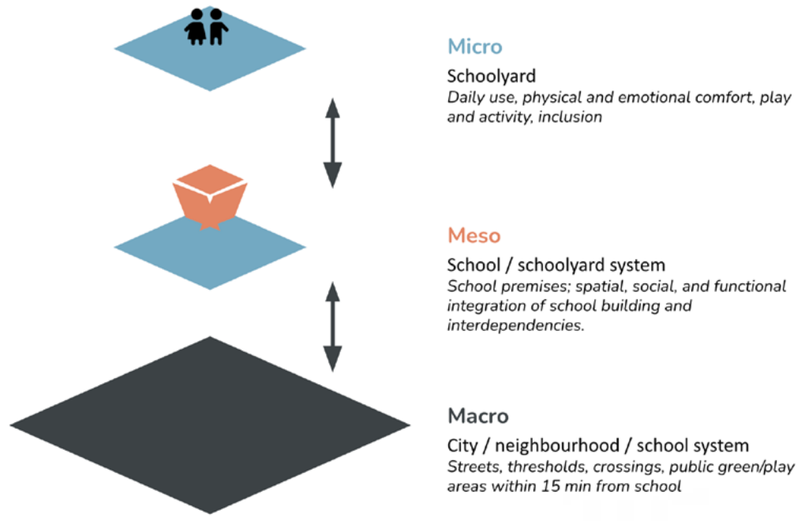
To fully understand how school environment affects child health it is essential to consider its spatial complexity. A child's experience doesn't start at the school gate – it begins at home and the journey to school. The quality, safety, and inclusivity of public spaces encountered on the journey to school significantly shape their health, autonomy, and emotional well-being. Sidewalks, crossings, green corridors, and neighborhood parks are not neutral backgrounds but active determinants of children's everyday lives.

Therefore, REACTIVE Framework operates across three nested scales addressing children experience systemically: the journey to school, the school premises, and the schoolyard are interdependent.

Macro Scale explores the neighbourhood in which the school is located. The aim is to assess exposure to heat/noise, access to green networks, air and noise quality, the walkability or bikeability of routes to school, and other relevant factors influencing health and wellbeing of children on their daily routes to and form school. This scale and respective tools can be relevant for the design of green school networks and/or school streets.

Meso Scale focuses on the school premises as a system of thresholds, where building envelope and access spaces mediate outdoor–indoor comfort, exposure, and health.

Micro Scale explores the schoolyard, its affordances, play structures, vegetation, surface materials, shading, and sensory elements that directly shape children's experiences.

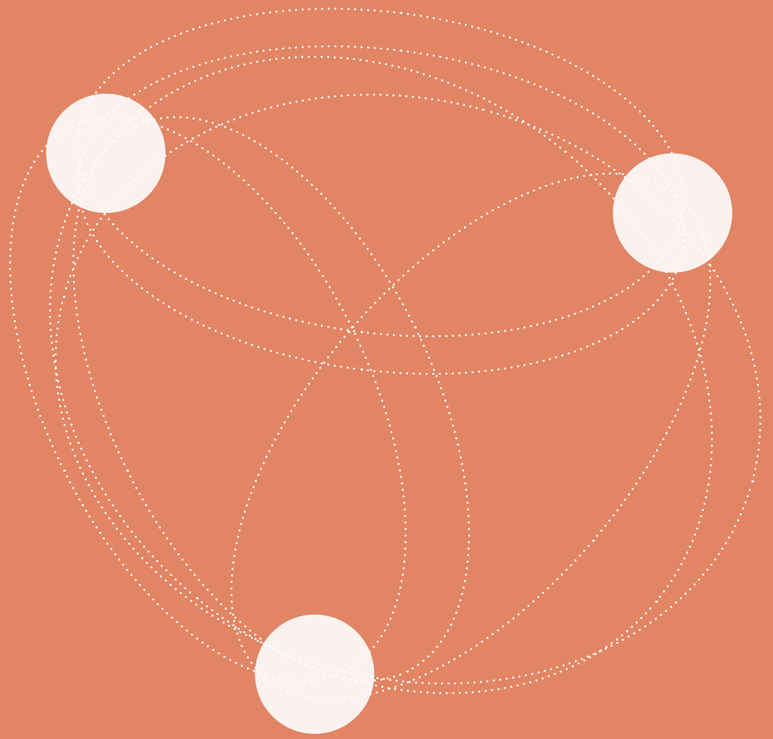


REACTIVE three-scales

PART 2 –

REACTIVE Methodology & Processes

Putting Framework into practice



REACTIVE Methodology

The REACTIVE methodology provides a clear, evidence-based process for transforming schoolyards and school-related micro-urban environments into climate-resilient, inclusive, and development-supportive spaces. It is designed to be adaptive, iterative, and action-oriented, grounded in climate-risk logic and aligned with key principles from IPCC, EEA, and WHO.

The methodology is organized into three phases, supported by a continuous validation loop. Though presented as a sequence, the process is not linear: each phase can begin, pause, or repeat depending on context, available data, and project needs. Together, the phases and the validation loop form a learning cycle that aligns climate-risk analysis, child development, and place-based design.

Step 1 – Understand & Explore
Step 2 – Set Goals, Priorities & Response Options
Step 3 – Design & Implement Responses
Validation Loop – Evaluate & Adjust (repeat audits)

Table 2. RE-ACT Schools Three steps Methodology.

Phase	Purpose	Outputs	IPCC Link
1. Understand & Explore	Diagnose risks, exposure, vulnerability; map use & behaviour	Baseline audit, needs map, risk profile	Hazard, Exposure, Vulnerability
2. Set Goals, Priorities & Response Options	Transform risks into strategic objectives and KPIs	Goals, KPIs, response options	Adaptation planning
3. Design & Implement Responses	Develop spatial, ecological, and infrastructural interventions	Design strategies & built transformation	Adaptation responses
Continuous Validation Loop	Monitor, evaluate, and adjust	Evidence of impact, iterative improvements	Effectiveness of adaptation responses & adaptive management

The REACTIVE methodology guides action without prescribing one-size-fits-all solutions. By combining risk-based analysis, child-centred design, and continuous learning, it supports context-sensitive transformations that reduce health risks while strengthening the everyday environments children rely on.

PHASE 1 - Understand & Explore

Develop a shared, evidence-based understanding of climate risks, exposure patterns, vulnerabilities, and everyday use of school-related environments.

Climate & environmental risks, spatial inequities, child development needs, lived experience

IPCC link *Hazard · Exposure · Vulnerability*

- Mapping local climate risks (e.g., heat, air pollution, UV radiation, flooding)
- Identifying vulnerable populations and spatial inequities
- Analysing exposure patterns (routes to school, outdoor use, surfaces, microclimate at child height)
- Observing behaviour and use (where children play, gather, avoid, or overheat)
- Using participatory tools with children, staff, and families as diagnostic instruments (to reveal lived experience)

- REACTIVE Audit (macro · meso · micro)
- REACTIVE Co-design tools
- REACTIVE hazard and vulnerability cards
- GIS overlays and existing climate/health vulnerability indexes
- IoT or sensor monitoring (when available)
- Site observations, walks, surveys

- Baseline climate and spatial audit
- Risk and exposure profile
- Needs and opportunity map
- Initial understanding of child development requirements

City/district
Identify priority schools
Macro scale
Diagnose and identify school streets
Meso scale
Diagnose building-edge and access-zone weaknesses
Micro scale
Identify microclimatic, functional, and inclusion gaps in the schoolyard

PHASE 2 - Understand & Explore

Create shared vision by translating risks and needs into shared priorities, measurable goals, and strategic response directions.

Decision-making, prioritisation, alignment

IPCC link *Adaptation planing*

- Translating audit results into clear design priorities
- Facilitating participatory goal-setting with municipalities, schools, and communities
- Aligning goals with institutional mandates and educational objectives
- Defining Key Performance Indicators (KPIs) for climate resilience, health, activity, and equity
- Identifying response options (e.g. “increase shaded comfort”, “restore permeable soils”, “improve independent mobility”)
- Using co-design as a prioritisation tool (to validate trade-offs and build legitimacy), not only idea generation

- REACTIVE Audit (macro-meso-micro)
- REACTIVE hazard and vulnerability cards
- Priority matrix and KPI checklist
- Response option matrix (risk →objective →strategic direction)
- REACTIVE Co-design tools

- Shared goals and priorities
- Response option matrix linking risks to strategic directions

City/district
Define strategic program goals, select thematic priorities
Macro scale
Prioritize needs: accessibility, thermal comfort, rainwater management, etc
Meso scale
Diagnose building-edge and access-zone weaknesses
Micro scale
Set site-specific goals: increase shaded zones, promote outdoor learning, enable year-round use.

PHASE 3 - Design & Implement Responses

Translate shared visions and objectives into concrete design interventions tailored to climate and health outcomes.

Spatial design, implementation, feasibility

IPCC link *Adaptation responses*

- Testing design options against audit indicators and site conditions
  - Use design indicators and guidelines
  - Select context-sensitive solutions from the Catalogue
  - Use child development and health-risk matrices to support decision-making
  - If resources allow, simulate interventions (e.g., with ENVI-met software)
- Using modular or tactical strategies to allow phased implementation
- Coordinating permits, budgeting, and contracting

- REACTIVE lenses
- REACTIVE Design Guidelines & Solutions
- Tactical urbanism for prototyping (e.g., pop-up shade, painted play zones)
- Guidelines for materials, vegetation, and permeability
- Design simulation tools (e.g, ENVI-met, shading analysis)

- Roadmap
- Design proposals and drawings
- Built or prototyped interventions

City/district
Guidelines for all schoolyards
Macro scale
School streets network
Meso scale
Entry redesigns, greening parking lots, managing runoff
Micro scale
Layout and detail of play areas, shelters, greenery, and circulation

VALIDATION LOOP – Evaluate & Adjust

Verify whether interventions reduce risk and improve comfort, inclusion, and use, and feed learning back into future iterations.

Learning, iteration, adaptive capacity

IPCC link *Effectiveness & adaptive management*

- Integrated pre-, during-, and post-intervention monitoring
  - Evaluate:
  - Thermal performance
  - Use and behavior
  - Biodiversity and sensory quality
  - Equity and access
- Applying indicators from the Toolkit and adapting them to local capacity
- Use results to revisit goals, adjust strategies, and inform future actions

- REACTIVE Audits (Pre/Post)
- User feedback tools (surveys, workshops)
- ENVI-met for microclimate simulations (where possible)

- Evidence of impact
- Adjusted strategies and designs
- Transferable knowledge for scaling and policy integration

City/district
Compare impact across transformed schools, evaluate program effectiveness
Macro / Meso scale
Thermal scans, pedestrian counts, comfort ratings
Micro scale
Behaviour mapping, student feedback, shade/rain-use diaries

Four example patways

Four example pathways
In the REACTIVE Framework, the term “process” refers to the series of steps taken to transform or design education-related urban spaces into climate-resilient, health-promoting, and inclusive places.

While the methodology provides a shared roadmap, the application of the REACTIVE Framework remains flexible and responsive to the spatial scale and context. It can vary depending on scale (neighborhood, city, or single school) and starting conditions (policy-driven, community-led, or design-initiated).

For example, in a city-wide program, Step 1 (risk mapping) may involve institutional datasets and policy mapping. On the other hand, a single-school intervention process might be based on interviews, school observations, or a climate audit.

Following a few examples.

EXAMPLE 1
City-Scale Process: Identifying Vulnerable Schools

Prioritize schools for climate-health interventions based on neighborhood risks and inequities.
Where should we intervene first, and why?

	What to do?	*Tools/Tips*
1	Map climate risks, air pollution, access to green space, and demographic vulnerability	GIS/institutional datasets
2	Define what “vulnerability” means in that context (e.g., highest UHI + low tree cover + low-income area)	Criteria matrix
	Validate risk areas with stakeholders (e.g., urban planners, school officials, school community)	Participatory mapping
3	Score schools, identify priority zones, and communicate to decision-makers	Visual summary/ dashboard
V	Reassess data every 2–3 years to track change or emerging needs	Baseline vs. updated layers

- A GIS-based vulnerability map of all schools in the city/ district
- A ranked list of priority schools (e.g. high / medium / low risk categories)
- A short vulnerability profile per priority school (1-page factsheet summarising key risks and drivers)
- An evidence base to support funding allocation, policy decisions, and pilot selection

Public administration, mobility planners, public works, climate adaptation teams

EXAMPLE 2
MACRO scale: Identifying Vulnerable Schools

Improve climate resilience, safety, and health conditions along children's daily routes to school by addressing systemic risks at neighbourhood or district scale.
Which streets and nodes should be redesigned together to reduce exposure and support independent mobility?

	What to do?	*Tools/Tips*
1	**Analyse climate and environmental risks affecting routes to school (urban heat, noise, air pollution, flooding); map walkability, crossings, shade, and access to green infrastructure**	*REACTIVE Audit (macro); GIS layers; mobility and heat maps*
2	**Define strategic goals (e.g. reduce heat exposure on routes, improve independent mobility); prioritise streets, crossings, and clusters of schools**	*Priority matrix; vulnerability criteria; stakeholder workshops*
3	**Develop coordinated interventions (school streets, tree corridors, shaded paths, traffic calming, etc.)**	*REACTIVE guidelines; solution palette; pilot interventions*
V	**Test/ Evaluate proposed solutions**	*REACTIVE Audits pre/post, Occupancy evaluation, and/ or ENVI-met*

- **A school-route risk map identifying critical streets, crossings, and segments.**
- **A prioritised intervention corridor plan (e.g. "School Street Network" or "Climate-Safe Routes to School")**

Public administration, mobility planners, public works, climate adaptation teams

EXAMPLE 3
MESO scale: School premises & Tresholds

Improve outdoor–indoor comfort, accessibility, and climate performance by transforming school premises as a system of thresholds between the city and the schoolyard.
How should the school building and its edges work as a climate buffer and inclusive interface?

	What to do?	*Tools/Tips*
1	**Assess microclimatic conditions at the entrance; analyse building envelope performance, access spaces, and transition spaces**	*REACTIVE Audit (meso); site observations; thermal scans*
2	**Define priorities such as reducing heat at entrances, improving shaded waiting areas, managing runoff near the building, and ensuring inclusive access**	*KPI checklist*
3	**Implement envelope-related and threshold interventions (shading devices, green façades, redesigned entrances,etc.)**	*Design guidelines; material strategies; modular solutions*
V	**Test/ Evaluate proposed solutions**	*REACTIVE Audits pre/post, Occupancy evaluation, and/or ENVI-met*

- **A school premises climate–comfort assessment (entrances, façades, access areas)**
- **A set of priority threshold zones (e.g. entrances, waiting areas, drop-off points)**
- **A design brief or retrofit strategy for the school premises, including: envelope-related interventions, access and accessibility upgrades, runoff and shading measures**

Public administration, architects

EXAMPLE 4
MICRO scale: Schoolyard transformation

Design a schoolyard that is climate-resilient, inclusive, and developmentally supportive.
How climate resilient is our schoolyard? Where and how can we reduce risk and support development?

	What to do?	*Tools/Tips*
1	**Assess risks and opportunities in the yard (e.g., heat, flooding, lack of play)**	*REACTIVE audit Observations, Occupancy evaluation, and/or ENVI-met*
2	**Define what needs to improve (e.g., thermal comfort, accessibility, play diversity) Work with children, staff, and families to co-develop ideas**	*Checklist of priorities,* REACTIVE Co-design tool
3	**Apply solutions (e.g., trees, play zones, bioswales, shade structures)**	*REACTIVE Guidelines & Solutions*
V	**Test/ Evaluate proposed solutions**	*REACTIVE audit (pre/post), Occupancy evaluation, and/or ENVI-met*

- **A site-specific schoolyard concept or detailed design**
- **A clear layout of play, learning, comfort, and ecological zones**
- **A selected set of nature-based and inclusive interventions linked to identified risks**
- **A before/after performance comparison (e.g. shade %, surface temperature, usability)**
- **Co-design documentation showing how children's input informed design choices**

Public administration, designers, schools

PART 3 –

REACTIVE Tools

REACTIVE Tools

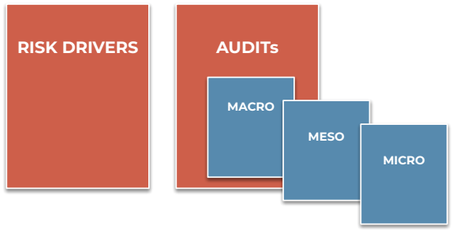
The REACTIVE Tools translate the framework into a practical, step-by-step workflow that helps users move from problem recognition to prioritised action across school-related environments. The toolkit is intentionally modular and tools can be used independently or combined.

The tools follow a clear default logic aligned with the IPCC-inspired risk framing adopted in this research: identify key risk drivers and their impacts (**WHAT**), locate and characterise them through multi-scale audits (**WHERE**), understand who is most affected through vulnerability and persona tools (WHO), align priorities and build shared ownership through co-design (**ENGAGE & ALIGN**), and finally translate findings into strategic guidance and implementable interventions (**HOW + WHICH**).

Together, these tools support a consistent diagnosis-to-design process that is transferable across contexts and scales, while keeping children's health, well-being, and development as the central decision lens.

WHAT is the problem?
(symptoms & impacts)

WHERE is the problem?
(diagnosis)



WHO is most affected?
(equity lens)

Engage and Align.
(needs, shared vision and priorities)

HOW to respond?
(strategy/treatment)

WHICH interventions to implement?
(specific solutions)

RISK DRIVER Cards

This section introduces the five risk drivers analyzed within the REACTIVE Audit. Each of these dimensions represents a specific cluster of environmental and spatial challenges that can undermine child well-being if not addressed through thoughtful design. While each driver can be evaluated individually, they often interact, creating complex patterns of vulnerability and requiring integrated responses.

Extreme temperatures / Urban Heat Island Effect

WHAT IS THE URBAN HEAT ISLAND EFFECT?
An Urban Heat Island (UHI) is the temperature difference between urban areas and their surrounding rural areas, caused by dense development, a lack of vegetation, and human-generated heat. Urban materials absorb and retain heat during the day and release it slowly at night, making cities hotter–especially during summer and nighttime hours. In schools and child-focused spaces, this intensifies discomfort, increases health risks, and limits activity.

WHY IT MATTERS? *UHI amplifies health inequities and affects children's comfort, development, and ability to learn and play.*

CONTRIBUTING FACTORS & INDICATORS

Factor	Indicator / Metric	Assessment Methods
Impervious Surfaces	% sealed ground (e.g., asphalt, concrete)	Surface mapping, satellite data
Vegetation & Shade Cover	Tree canopy %, NDVI, % shaded area during peak hours	Site surveys, aerial imagery, and sun path analysis
Building Morphology	Sky View Factor, height-to-width ratio (canyon effect)	Morphological analysis, 3D modeling
Surface Albedo	Reflectivity index of materials	Material inventory, thermal imaging
Anthropogenic Heat	Presence of traffic, industry, and HVAC systems	Land use maps, energy use proximity
Airflow & Ventilation	Presence of ventilation corridors, stagnant zones	Wind simulations, site observation

HEALTH & CHILD DEVELOPMENT IMPLICATIONS

Impact	Description
Physiological Stress	Children are highly sensitive due to lower sweat rates, immature thermoregulation, and higher metabolic heat during play.
Cognitive Function	Exposure to heat impairs attention, short-term memory, and problem-solving skills, especially in classroom settings.
Emotional & Social Well-being	Heat stress increases irritability, reduces peer interaction, and leads to discomfort and withdrawal from group play.
Physical Activity Decline	Children avoid outdoor movement when it's too hot, undermining motor development and healthy routines.

Younger children and children with chronic conditions are at greater risk. UHI not only affects comfort–it alters core experiences of learning and play.

Extreme temperatures / Urban Heat Island Effect

SYNERGIES & TRADEOFFS

Lens	Synergies	Trade-offs
	Green infrastructure for cooling also improves infiltration and reduces runoff.	Some permeable materials retain heat if unshaded.
	Vegetation for cooling also doubles as habitat, supporting biodiversity.	Needs ecologically appropriate planting and water-efficient species.
	Cooler, shaded spaces support safe movement and outdoor learning.	Large trees may reduce open play areas if poorly located. IN WINTER...
	UHI mitigation can prioritize underserved, heat-vulnerable communities.	Risk of "green gentrification" if improvements are not equitably distributed.

TAKE AWAY FOR DESIGN & POLICY

+ UHI mitigation in school environments supports climate resilience, child health, equity, and developmental opportunity.
+ Solutions must be site-specific, balancing shade, ventilation, activity space, and ecological fit.
+ UHI indicators should be integrated into climate audits, schoolyard transformation plans, and urban policy frameworks.

DESIGN NOTE! *Synergies can be maximized with integrated planning. For example, trees near permeable playground surfaces improve both shade and drainage.*

Extreme precipitations / Stormwater Runoff

WHAT IS STORMWATER RUNOFF?

Stormwater runoff is the excess water from rainfall or snowmelt that flows over impermeable surfaces (such as asphalt, roofs, and concrete) rather than infiltrating into the soil. In natural systems, most rainwater is absorbed, but in cities, runoff can overwhelm drainage systems, leading to localized flooding, infrastructure damage, pollution, and erosion.

WHY IT MATTERS? *Unmanaged stormwater contributes to urban flooding, increases exposure to pathogens and pollutants, and degrades the safety and usability of play and learning environments–especially for children.*

CONTRIBUTING FACTORS & INDICATORS

Factor	Indicator / Metric	Assessment Methods
Surface Permeability	% of permeable vs. impermeable ground	Ground survey, GIS-based surface classification
Drainage Infrastructure	Presence, type, and condition of drains/ gutters	Visual inspection of municipal infrastructure maps
Topography and Slope	Gradient and flow direction	Site survey, topographic analysis
Vegetation & Soil Cover	Green area %, infiltration rate	On-site testing, soil analysis, NDVI
Runoff Volume & Intensity	Estimated L/m² of runoff per rain event	Hydrological models, rainfall/runoff calculations
Pooled Water Zones	Presence of puddles or standing water after rain	Field observation, drainage spot checks

HEALTH & CHILD DEVELOPMENT IMPLICATIONS

Impact	Description
Flooding Hazards	Children are more susceptible to slipping, falling, or becoming trapped in flooded low areas.
Pathogen Exposure	Contact with polluted runoff water (containing fecal matter, oil, or trash) increases the risk of infection.
Play and Mobility Restrictions	Water accumulation reduces access to play areas, sports courts, and school entries.
Infrastructure Damage & Safety	Erosion and damage to paving may lead to injuries or reduce caregivers' perceived safety.

Poor drainage and hardscaping not only cause inconvenience, they also expose children to health and safety risks, limit physical activity, and degrade trust in public environments.

Extreme precipitations / Stormwater Runoff

SYNERGIES & TRADEOFFS

Lens	Synergies	Trade-offs
	Permeable surfaces and vegetation reduce both runoff and surface temperatures.	Some water-retentive surfaces may remain wet, increasing local humidity.
	Raingardens and bioswales enhance biodiversity and habitat connectivity.	Improper plant selection or over-engineering may reduce ecological value.
	Dry, well-drained paths and play zones ensure year-round usability.	Floodable play zones may need temporary closures or increased maintenance.
	Prioritizing runoff solutions in underserved areas enhances environmental justice.	Poor maintenance can disproportionately affect marginalized neighborhoods.

TAKE AWAY FOR DESIGN & POLICY

+ Stormwater-sensitive design enhances safety, usability, and health in urban child environments.
+ Prioritize permeability, green-blue infrastructure, and passive drainage solutions.
+ Integrate stormwater strategies within schoolyards, sidewalks, crossings, and open play zones—ensuring co-benefits with heat mitigation, biodiversity, and active mobility.

DESIGN NOTE! *Nature-based solutions (e.g., rain gardens, infiltration trenches) offer multifunctional benefits and are ideal for child-centered, climate-resilient design.*

Biotope Loss

WHAT IS BIOTOPE LOSS?

Biotope loss refers to the degradation or elimination of natural habitats within urban environments. As green spaces are replaced by impervious surfaces and fragmented by infrastructure, the richness of local biodiversity declines. This weakens ecosystem services such as air purification, cooling, water regulation, and habitat provision—especially in densely populated urban areas.

WHY IT MATTERS? *Biotope loss reduces cities' capacity to adapt to climate change, increases exposure to environmental stressors, and limits children's daily contact with nature, which is essential for healthy development.*

CONTRIBUTING FACTORS & INDICATORS

Factor	Indicator / Metric	Assessment Methods
Vegetation and Habitat Coverage	% of area covered by native plants or habitat types	NDVI, land use mapping, ecological surveys
Habitat Fragmentation	Patch size, connectivity index, corridor loss	GIS spatial analysis, patch connectivity models
Species Richness	Number of native species (flora and fauna)	Biodiversity inventories, ecological monitoring
Soil Health	Presence of living soil and organic matter	Soil sampling, vegetation health observations
Use of Invasive Species	% of non-native or invasive plant species	Site audit, plant species identification
Ecological Management	Maintenance aligned with ecological cycles	Review of maintenance plans and practices

HEALTH & CHILD DEVELOPMENT IMPLICATIONS

Impact	Description
Reduced Sensory Stimulation	Lack of natural environments limits sensory variety and inhibits experiential learning.
Mental Health & Stress	Nature contact is linked to lower anxiety, better mood, and emotional regulation in children.
Physical Activity	Ecological play zones (e.g., logs, boulders, trails) promote active, exploratory movement.
Loss of Environmental Awareness	Limited exposure to biodiversity reduces children's empathy, curiosity, and understanding of ecosystems.

Frequent interaction with biodiverse, natural spaces improves cognitive performance, attention restoration, and emotional resilience in children.

Biotope Loss

SYNERGIES & TRADEOFFS

Lens	Synergies	Trade-offs
	Vegetation supports shading and evapotranspiration for cooling.	Dense vegetation may block airflow if not planned carefully.
	Natural soil and plant systems retain and filter rainwater.	Overuse of turfgrass may lead to low biodiversity and limited infiltration.
	Naturalized play areas encourage risk-based and imaginative movement.	Requires a balance between wildness and caregivers' perceived safety.
	Access to biodiverse spaces enhances nature equity and educational opportunity.	Maintenance and stewardship gaps can widen inequity if poorly distributed.

TAKE AWAY FOR DESIGN & POLICY

+ Biodiversity-positive design supports health, education, and climate resilience in school environments.
+ Replace monocultural lawns and ornamental shrubs with multi-layered, native vegetation.
+ Integrate habitat corridors, pollinator gardens, and naturalized zones into schoolyards and urban micro-environments.
+ Ensure long-term ecological maintenance plans and promote community stewardship.

DESIGN NOTE! *Prioritize native, low-maintenance vegetation and connected habitat patches in and around schools to ensure ecological continuity and playful, safe engagement with nature..*

Physical (in)activity

WHAT IS PHYSICAL ACTIVITY?

Physical activity is a core determinant of child health, supporting motor development, cardiovascular health, cognitive performance, and emotional well-being. In school-related environments, movement occurs through active commuting, recess, unstructured play, and structured exercise. The design and condition of public spaces—including schoolyards, sidewalks, play areas, and crossings—either encourage or inhibit children's ability to move freely and safely.

WHY IT MATTERS? *Physical inactivity is a leading contributor to non-communicable diseases. In children, it also delays developmental milestones and reduces resilience, especially in vulnerable populations.*

CONTRIBUTING FACTORS & INDICATORS

Factor	Indicator / Metric	Assessment Methods
Walkability & Connectivity	Path continuity, directness, intersection density	Network analysis, GIS mapping
Safety & Comfort	Traffic speed, lighting, and the presence of sidewalks	Field audit, traffic data, perception surveys
Play Infrastructure	Presence, quality, and variety of play/sport equipment	On-site inventory and condition assessment
Informal Play Opportunities	Natural and flexible spaces for free movement	Visual survey, behavioral observation
Accessibility & Inclusion	Use by all genders, ages, and abilities	Equity mapping, user surveys
Weather-Responsive Design	Shade, drainage, and thermal comfort	Climate audit, sun path, and rainfall analysis

HEALTH & CHILD DEVELOPMENT IMPLICATIONS

Impact	Description
Motor and Cognitive Development	Active environments support coordination, balance, spatial reasoning, and attention regulation.
Mental Health & Emotion	Physical activity reduces stress and supports emotional resilience.
Social Inclusion	Shared movement and play build friendships and peer cooperation.
Obesity and NCD Prevention	Active lifestyles help prevent being overweight and the early onset of cardiovascular/ metabolic conditions.

Children need at least 60 minutes of moderate-to-vigorous physical activity per day. Spatial barriers, poor safety, and lack of infrastructure are key constraints—especially for girls and marginalized groups.

Physical (in)activity

SYNERGIES & TRADEOFFS

Lens	Synergies	Trade-offs
	Activity zones shaded by trees support both movement and thermal comfort.	Movement increases metabolic heat; thermal risk must be considered in design.
	Play areas can double as rain gardens or floodable zones.	Wet or poorly drained areas may reduce usability and increase injury risk.
	Natural play promotes sensory richness and biodiversity interaction.	Vegetated terrain may reduce accessibility if left unmanaged or unlevel.
	Inclusive design ensures all children have safe and accessible places to move and play.	Poor maintenance or fear of crime may lead to uneven usage across groups.

TAKE AWAY FOR DESIGN & POLICY

+ Promote physical activity through safe, inviting, and inclusive urban design.
+ Integrate movement-supportive features into schoolyards, school routes, crossings, and micro-parks.
+ Address both structured (sports courts, tracks) and informal (logs, trails, shaded zones) activity needs.
+ Monitor use patterns and remove barriers for girls, younger children, and children with disabilities.

DESIGN NOTE! *Combine formal sports zones with natural, unstructured environments and ensure gender-sensitive, age-appropriate, and climate-responsive infrastructure.*

Spatial Inequity

WHAT IS SPATIAL INEQUTIY?

Spatial inequity occurs when urban spaces and services—such as green areas, schoolyards, safe routes, and public amenities—are unevenly distributed, poorly maintained, or inaccessible to specific populations. Children living in marginalized areas, with disabilities, or from lower-income backgrounds often face multiple barriers to health-supportive environments.

WHY IT MATTERS? *When children cannot access or safely use their environment, their right to play, learn, and move freely is denied—exacerbating long-term health and social inequalities.*

CONTRIBUTING FACTORS & INDICATORS

Factor	Indicator / Metric	Assessment Methods
Physical Accessibility	Presence of ramps, curb cuts, path width, tactile cues	Universal design audit, mobility mapping
Infrastructure Quality	Pavement condition, seating, shelter, lighting	Field inspection, user feedback
Safety & Perceived Security	Traffic speed, street lighting, surveillance	Traffic data, perception surveys
Distance to Green Space	Walking distance from schools/residences	GIS proximity analysis
Service Distribution	Access to activities/services	Equity mapping, resource audits
Inclusive Design Elements	Gender-sensitive, age-friendly, and ability-inclusive features	Observational use patterns, design audit

HEALTH & CHILD DEVELOPMENT IMPLICATIONS

Impact	Description
Restricted Mobility	Unsafe or broken paths limit autonomy and increase dependence on adults.
Social Isolation	Children without access to public spaces miss out on peer interaction and a sense of belonging.
Reduced Physical Activity	Lack of accessible, safe, and engaging spaces reduces daily movement and active commuting.
Health Inequities	Environmental and infrastructural gaps contribute to chronic stress, injury risk, and illness.

Equity in access to healthy environments is foundational to achieving developmental, emotional, and physical well-being—especially for children from underrepresented or vulnerable groups.

Spatial Inequity

SYNERGIES & TRADEOFFS

Lens	Synergies	Trade-offs
	Equitable tree planting and shade provision reduce heat exposure for underserved communities.	Dense vegetation must be balanced with visibility and perceived safety.
	Distributed green infrastructure improves drainage in neglected neighborhoods.	Improperly maintained areas may worsen accessibility or reinforce neglect.
	Safe, inclusive environments encourage daily movement for people of all ages and abilities.	Design must address both safety and comfort, especially for girls and disabled children.
	Naturalized, accessible areas support ecological awareness and inclusive exploration.	Natural terrain may limit use if not adapted for wheelchair/stroller access.

TAKE AWAY FOR DESIGN & POLICY

+ Spatial equity means not just providing infrastructure—but ensuring it is safe, accessible, inclusive, and desirable for all users.
+ Prioritize investment in neglected neighborhoods, especially around schools and child-centered facilities.
+ Embed universal design principles and inclusive programming in all interventions.
+ Track and evaluate spatial equity using GIS, mobility audits, and participatory feedback.

DESIGN NOTE! *Combine universal design, community participation, and data-driven mapping to identify and address inequities in public space access and quality.*

This page is intentionally left blank.

CHILD DEVELOPMENT

Vulnerability profiles

.....

.....

.....

.....

.....

.....

.....

.....

.....

Child development

WHAT IS CHILD DEVELOPMENT?

Child development is shaped by everyday environmental conditions and by what a space allows children to do (move, explore, interact, withdraw, take manageable risks). In schoolyards and school-related environments, design decisions can either support developmental progression (across ages and abilities) or create "failure conditions" (overstimulation, exclusion, inactivity, conflict).

WHY IT MATTERS? *When environments are monofunctional, unsafe, overstimulating, or climate-disrupted, children lose key opportunities for motor development, self-regulation, autonomy, social learning, and sensory calibration—with unequal impacts on younger children, neurodiverse users, and those with limited mobility.*

DEVELOPMENTAL NEEDS

Factor	Indicator
Movement + skill progression	gross/fine motor, coordination, strength
Self-regulation	ability to step down from stimulation, recover, re-enter
Autonomy	self-directed choice, safe independence, legible rules
Social development	co-play, peer belonging, conflict negotiation
Sensory calibration	not sterile, not overwhelming; gradients

SPATIAL QUALITIES

Impact	Description
Affordance variety	climb/balance/hang/hide/roll/kick/dig (avoid single-mode yards)
Activity gradient + zoning	quiet - semi-active - active, visually connected, buffered to reduce conflict/ overstimulation
Social spectrum	large-group fields + small-group pockets + solitary refuge
Neurodiversity support	calm breaks, tactile cues, reduced clutter/noise hotspots

AVOID

+ "One big hard plane" (low affordance diversity > conflict + inactivity).
+ No retreat (constant exposure > dysregulation, exclusion of sensory-sensitive users).
+ Over-controlled social space (adolescents displaced; edges become hostile/circulation-only).
+ Climate makes it unusable (heat/glare, puddling, slippery transitions > play collapses).

Child development

INDICATORS FOR AGE-RESPONSIVE DESIGN.

Indicator	Why it matters	How to measure?	Suggested Benchmark (illustrative)*	References
Distinct spatial zones by age group (in case of different school levels)	Ensures toddlers, primary-age children, and adolescents each have environments scaled to their physical size, risk tolerance, and social needs.	• Site layout plan annotated by designers • Post-occupancy mapping of user distribution (15-min interval scans)	≥ 3 clearly demarcated zones on sites serving multiple age groups	UNICEF (2018); Moore & Cosco (2019)
Variety of physical affordances (climbable, balance, hang, hide, roll, kick, dig)	Supports motor-skill progression and prevents dominance of a single play type.	• Affordance inventory checklist • Photographic survey	≥ 7 affordance types in preschool yards; ≥ 10 in primary; ≥ 12 in secondary	Gibson (1979); Andersen et al. (2022)
Provision of natural loose parts (sticks, stones, leaves, sand, water)	Fuels symbolic play, creativity, sensory integration, and fine-motor refinement.	• Quadrat counts of loose-part density • Teacher log of replenishment	Loose-part density ≥ 15 items m² in early-childhood corners; ≥ 5 items m² in primary nature zones	Bundy et al. (2017)
Quiet / restorative micro-spaces	Enables self-regulation, small-group conversation, and stress recovery—critical for neurodiverse and adolescent users.	• Count of seating or refuge niches sheltered from main activity flow	≥ 1 quiet nook per 30 users; noise ≤ 55 dB(A) daytime	Moore & Cosco (2019); WHO (2018)
Shade and UV protection proportion (further detailed under urban heat)	Protects sensitive skin and enables longer outdoor stays, especially for ages 0–10.	• GIS canopy analysis + structure shade footprint	Minimum 50 % shade over early-childhood zone; 30 % over primary active zone	WHO (2016)
Surface diversity / texture ratio	Different textures aid balance training, proprioception, and sensory seeking.	• % of yard in turf, mulch, rubber, permeable paving, earth	At least 4 distinct surface types present	Fjørtoft & Sageie (2009)
Risk-benefit play elements (heights, loose logs, boulders)	Appropriate challenge supports confidence and risk competence.	• Risk/benefit audit form (UK Play Safety Forum)	Presence of graduated height elements (0.6 m–1.2 m preschool; 1 m–2.4 m primary)	Sandseter (2010) add ISO standards
Adolescent social autonomy features (Wi-Fi spots, seating clusters, murals)	Responds to identity formation and peer-bonding needs of 12-18-year-olds.	• Count of semi-enclosed seating clusters, creative expression walls	≥ 1 cluster / 20 students; ≥ 1 surface allocated for student art	Chawla (2015)
Accessibility / universal design score (further detailed under spatial inequity)	Guarantees inclusion of users with mobility, sensory, or cognitive differences across ages.	• EU / national checklist	90 % of zones meet accessibility criteria; zero –step entry to all main areas	Steinfeld & Maisel (2012)

**Benchmarks are indicative starting points drawn from the cited literature; they should be calibrated to local regulations.*

CHILDREN
3-6 YRS

What makes them vulnerable?

+ Low heat tolerance; fast overheating in sun/windless pockets
+ Low hazard awareness; high fall risk at edges/transitions
+ Wet surfaces = slips; puddles = play magnet + hygiene issue

Design priorities

+ Shade on play prompts + caregiver positions
+ Dry-feet routes + slip-safe transitions
+ Contained sensory variety + micro-refuges

Design solutions

+ Tree/canopy shade over play nodes
+ Textured, slip-safe surfacing at transitions
+ Contained loose-parts bay + low seating/handholds

CHILDREN
7-10 YRS

What makes them vulnerable?

+ High activity bursts > heat load + dehydration risk
+ Competition hierarchy > conflict/exclusion in single-court yards

Design priorities

+ Shade + cool ground at courts/queues
+ Keep loop usable after rain (permeable edges, dry connectors)
+ Parallel play options (avoid single "winner-takes-all" field)

Design solutions

+ Shaded perimeter loop + recovery nodes
+ Permeable sidelines; runoff intercepted by planted strips/tree trenches
+ Multiple small game markings instead of one dominant court

CHILDREN
7-10 YRS

Your notes:

.....
.....
.....
.....
.....
.....
.....
.....
.....

CHILDREN
3-6 YRS

Your notes:

.....
.....
.....
.....
.....

EARLY ADOLESCENTS
11-13 YRS

What makes them vulnerable?

+ Need belonging + semi-independence; displaced if space is over-controlled
+ Heat-storing “hangout slabs” block use in warm seasons

Design priorities

+ Shaded social edges + choice (sun/shade, near/far)

Design solutions

+ Pergola + integrated cluster seating
+ Covered entrance/queue pocket
+ Planted buffer edges that also detain runoff

ADOLESCENTS
14-18 YRS

What makes them vulnerable?

+ Teen displacement > conflict + off-site lingering
+ Heat/glare blocks sport + social life; rain breaks access/comfort continuity
+ Poor lighting > safety perception drops

Design priorities

+ Shaded sport + recovery as one system
+ All-weather access; covered outdoor study/ social where relevant
+ Social spaces

Design solutions

+ Canopy/pavilion + power/water
+ Ventilated shade structures + cool durable paving at building edge
+ Shaded calisthenics strip + well-lit social platform

ADOLESCENTS
14-18 YRS

Your notes:

.....
.....
.....
.....
.....
.....
.....
.....
.....

EARLY ADOLESCENTS
11-13 YRS

Your notes:

.....
.....
.....
.....
.....
.....
.....
.....
.....

MOBILITY LIMITED USERS
(Wheelchair, crutches, temporary injury)

What makes them vulnerable?

+ Surface discontinuities + slopes become barriers (worse when wet)
+ Detours increase heat exposure + reduce participation

Design priorities

+ Continuous dry-foot accessible route to core uses (not only perimeter)
+ Slip-safe textures; low thresholds; rest nodes in shade

Design solutions

+ Primary accessible spine (2.0–2.5 m) linking entry–toilet–play/social nodes
+ Shaded rest points every 30–50 m (context dependent)
+ Permeable surfaces chosen for wheel roll + maintenance reality

SENSORY-SENSITIVE / NEURODIVERGENT USERS

What makes them vulnerable?

+ Overstimulation (noise, crowding, glare, chaotic layout) triggers dysregulation
+ Exclusion happens when there's no legitimate retreat option

Design priorities

+ Predictable layout + tactile/visual cues
+ Quiet refuges near-but-off main flow (not isolated)
+ Glare control + shade distribution (not only one dark corner)

Design solutions

+ 2–3 calm pockets with seating + planting buffers
+ Tactile bands / clear boundaries at zone edges
+ Reduce noise hotspots with soft landscape + spatial separatiom

MOBILITY LIMITED USERS

Your notes:

.....
.....
.....
.....
.....

SENSORY-SENSITIVE / NEURODIVERGENT USERS

Your notes:

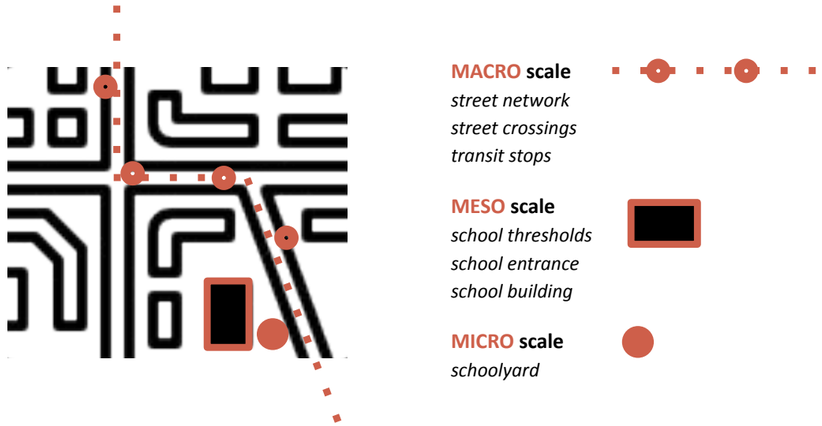
.....
.....
.....
.....
.....
.....
.....
.....
.....

This page is intentionally left blank.

REACTIVE Audits

Three-scale audit system

In line with the framework's conceptual approach, the audit is structured around a 3-scales, allowing a systemic view from neighborhood to schoolyard to child experience: macro (neighbourhood/routes), meso (school premises/ thresholds), and micro (schoolyard) scales.



MACRO – Urban & Neighborhood Context

Focus: Mobility, access, neighborhood climate risks
Use: Identify schools most at risk; map environmental and mobility barriers; map the quality of the pedestrian paths in terms of climate resilience and health impact leading to schools.

MESO – School + Tresholds

Focus: Integration of the schoolyard with the school layout and ecology
Use: Assess how building design, surface types, and vegetation interact, and explore how the school building contributes to climate resiliency.

MICRO – Human Experience and Comfort

Focus: Thermal, sensory, and play comfort from a child's perspective
Use: Pinpoint design needs for usability, comfort, and health.

What does the audit do?

The REACTIVE audit is built as a modular system which allows you to assess different child urban settings based on your needs. Each audit is built as a scored checklist designed to support rapid, on-site assessments that helps identify risk hotspots and prioritise actions.

The key components of each Audit are:

PART 1 - Set-up & Boundary
(Context & Scope definition)

PART 2 - Exposure profile
(Where are the exposure hot-spots?)

PART 3 - Vulnerability profile
(Who uses the space, and who is the most vulnerable?)

PART 4 - Risk-drivers assessment
(Which are the key risk-drivers?)

PART 5 - Child development support
(How well does the space support child development?)

RESULTS MATRIX
(Results Summary)

How to ...

.. score?

Audit scoring translates observations into a transparent, comparable performance snapshot. Each indicator is scored on a simple ordinal scale 0-2 using predefined criteria:

0 = missing/critical failure,
1 = partially present or inconsistent,
2 = present, functional, and robust under everyday use and extremes.

The aim is to guide design decisions and evaluate current conditions and design solutions.

How to read the results?

The REACTIVE scores describe:

Exposure (how often/when/where children are exposed to risk-drivers)
Vulnerability (who is more sensitive / less able to cope)
Risk-driver performance (how the space amplifies or buffers key risk-drivers)
Child development performance (how the space supports core developmental needs)

Together, they indicate the likelihood of adverse consequences for children's health, wellbeing, and development and what to prioritise in design.

RESULTS MATRIX

Component	Result	Interpretation	What it triggers
Exposure level	LOW / MED / HIGH	How much children encounter hazards	Amplifies urgency
Vulnerability level	LOW / MED / HIGH	Who is most sensitive	Outlines priority
Heat / UHI	LOW / MED / HIGH	Overheating drivers	Heat actions
Stormwater	LOW / MED / HIGH	Runoff/ponding drivers	Drainage/permeability actions
Biotope loss	LOW / MED / HIGH	Ecological buffering/nature contact	Greening/soil/habitat actions
Physical inactivity	LOW / MED / HIGH	Activity affordances + inclusion	Play/movement infrastructure
Spatial inequity	LOW / MED / HIGH	Unequal protection/access/safety	Redistribution/access/ supervision
Child development	LOW / MED / HIGH	Developmental performance	Ensures interventions support children

What each score tells you?

A. Exposure Profile (Part 2) = *"How much and where are children exposed?"*
HIGH exposure = even a "medium" hazard becomes urgent (kids are in it, often and long).
SLOW exposure = hazards still matter, but urgency may be lower or targeted to specific time windows.

B. Vulnerability Profile (Part 3) = *"Who is most at risk?"*
This score shows the user's sensitivity and coping capacity.
HIGH vulnerability = prioritize protective, inclusive, low-threshold measures (shade, step-free access, calm refuge, supervision, etc.).

C. Risk-driver lenses (Part 4) = *"What are the main drivers of risk in the space?"*
Each lens score shows the presence and intensity of a certain spatial/environmental risk-driver:

Extreme heat / UHI → overheating likelihood in real use zones (geometry, shade, materials, radiant load, cooling supports, airflow).
Stormwater → runoff/ponding likelihood in routes and use areas (permeability, ponding, drainage/retention).
Biotope loss → ecological quality + nature contact capacity (layers, diversity, living soil, habitats).
Physical inactivity → whether the yard invites movement for different users, not just "has a field".
Spatial inequity → equal distribution and access to affordance for different users (age/gender/ability/needs).

D. Child Development (Part 5) = *"Does the yard support developmental needs?"*
This is not a hazard score; it is a developmental performance check. The score shows weather the space support all child developmental needs, from motor to cognitive, social, emotional, sensory, autonomy, and inclusivity.
LOW developmental support = the space is underperforming and lacking the developmental support.

How to interpret different scores together?

If multiple lenses are "**HIGH risk**", expect compound stress (e.g., impermeable + no shade = heat + runoff + inequity). Use the Synergies/Tradeoffs icons to identify actions that can have multiple co-benefits or create conflicts if not managed properly that must be mitigated (see example below).

Synergy = improving this indicator can improve another lens (co-benefit)
Tradeoff = if poorly designed/managed, this indicator can can worsen another lens (a risk to watch)

LEGEND  **synergies**  **tradeoffs**	
Surface permeability	 Increasing ground permeability creates synergies with: Extreme Heat (cooler surfaces + evapotranspiration), Biotope (more living soil/ habitat), and Child Development/ Activity (sensory-rich, nature-contact surfaces). However, if not managed properly, it can involve trade-offs with Accessibility/Equity if surfaces become uneven/soft or harder to maintain. So the material use and maintenance must keep routes inclusive.

Lens-to-Health implications & design objectives

The REACTIVE audit does not diagnose health outcomes; it identifies environmental and spatial risk drivers and their exposure pathways. Health implications are provided as evidence-based links from the scientific literature in the following table,

Risk driver	Spatial drivers	Likely implications (evidence-based links)	Vulnerable users	Design objective
	high radiant heat + low shade + poor ventilation during outdoor time	higher likelihood of heat strain symptoms, dehydration risk, reduced outdoor activity, fatigue/irritability; cognitive fatigue during hot periods	higher risk for younger children and those with health conditions	reduce heat load; increase usable shaded areas; increase quality green areas (see biotope loss); improve airflow and reduce radiant surfaces in key use zones
	low permeability + poor drainage + ponding on routes + slippery surfaces	slips/falls/injuries; reduced outdoor time; restricted access (especially for mobility limitations); hygiene issues (mud/ water stagnation), risk of vector born disease (low) and mosquitos	higher risk for users with mobility challenges, younger children (falls)	increase infiltration/retention; keep routes and key zones usable
	low vegetation structure/diversity + no living soil + few habitat features	reduced microclimate buffering (more heat), fewer restorative effects, weaker nature contact linked to attention restoration and stress regulation; reduced opportunities for exploratory/sensory play	children with higher stress load; sensory-sensitive/neurodiverse users (often benefit from calmer, nature-rich settings)	restore ecological buffering and daily nature contact; increase multilayer vegetation and diversity; ensure living soil/plantable ground and accessible nature zones; add simple habitat features
	lack of varied affordances, loops, inclusive play options > sedentary or mono-activity use	lower daily movement, weaker motor skill development; reduced social inclusion (often gender/age differences); reduced resilience to heat (less fitness, lower coping capacity)	children with disabilities if routes/equipment are not inclusive; girls (often excluded by mono-fields)	enable varied, inclusive movement and “active circulation”; diversify affordances across zones; provide a loop/path + distributed micro-activities; offer alternatives to dominant competitive spaces
	uneven distribution of shade/seating, barriers, unsafe zones, exclusion patterns	unequal exposure to hazards, unequal access to restorative/ healthy conditions, social exclusion and reduced participation	compounding vulnerability for disability, younger age, or marginalised groups	ensure protective conditions and participation opportunities are distributed and accessible, remove barriers + improve safety/legibility
	limited developmental affordances + lack of legibility/ autonomy cues + few calm/learning/ social micro settings	weaker opportunities for motor/cognitive/social-emotional development and autonomy	younger children; children with low autonomy; sensory-sensitive/neurodiverse users; mixed-age groups needing differentiated challenge	increase developmental affordances across the whole yard: constructive/fine-motor options; outdoor learning nodes; calm retreat(s); sensory richness + nature play; autonomy cues and inclusive participation

1, 2, 3...

... start

You are looking for continuity, barriers, exposure, and "last 200 m" problems.

1) Prepare (15 min)
- Base map + school gate location
- Confirm audit time window + weather note (last 24–48h)
- Decide scope: Route / Crossing / Stop

2) Walk / scan (45–90 min)
- Trace main desire lines (children + caregivers)
- Mark barriers + risky segments
- Note missing links (shade, sidewalks, crossings, bike lanes)

3) Output (10 min)
- One annotated map
- A short list of priority hotspots (max 5)
- Photo log (min 10 photos) with location tags

MACRO scale audit

Assesing school access system in the neighbourhood (routes + crossings + transit stops)

Scope
- ☐ Pathway/Route
- ☐ Crossing
- ☐ Stop/Station

Context & identifiers

School name / ID: .....
Municipality / neighbourhood: .....
Date + time window observed: .....
Weather note (heat / rain in last 24–48h): .....
Auditors: .....

Boundary definition

Pathway/Route name + map reference: .....
Route length (approx.) + segments: .....
Crossing ID / location: .....
Stop/Station ID / location: .....
Constraints: .....

MACRO scale audit

PART II - Exposure profile

? *How often, how long, and where children (and caregivers) are out in the street network while travelling to/from school.*

Exposure indicator	Question / evaluation focus	Score (0–2)	Scoring guide	Method
Use intensity	*Do many school users use this route/node?*	.....	**0** = rarely **1** = moderate **2** = very frequent	Timetable + peak-time observation
Peak-condition exposure	*Are users outside during 12–15 (hot season) and/or during heavy rain events?*	.....	**0** = rarely **1** = sometimes **2** = often	Observation
Duration	*Typical time spent on this route/node (walking/waiting)?*	.....	**0** = short **1** = medium **2** = long	Observation + staff
Spatial concentration	*Is the use concentrated in the most exposed parts (full sun/ponding/traffic edge)?*	.....	**0** = avoided **1** = mixed **2** = concentrated	Mapping during peak time
			Maximum score = 8 0–2 = LOW Exposure 3–5 = MEDIUM Exposure 6–8 = HIGH Exposure	
Additional exposure stressors [optional, not scored]				
Air quality (perceived)	*Describe the outdoor air quality along the route and/or at the crossing/transit stops during a typical day (based on visibility, odors, nearby traffics, etc.). Are there obvious pollution sources affecting outdoor use?*		**0** = poor (obvious sources; exhaust smell/smoke/dust; outdoor use constrained) **1** = moderate (some sources; occasional odor/traffic influence) **2** = good (no obvious sources; outdoor use not constrained)	visual observation + olfactory perception
Noise quality (perceived)	*Describe the typical sound environment along the route and/or at the crossing/transit stops during the day (besed on background noise, nearby traffic, mechanical sounds, etc.).*		**0** = poor (traffic/mechanical noise dominates; hard to stay/teach outside) **1** = moderate (periodic peaks; outdoor use possible but limited) **2** = good (generally calm; outdoor use not constrained)	subjective observation on environmental context

MACRO scale audit

PART III - Vulnerability profile

User indicator	Data
Primary user group *(pick one, maximum two)*	☐ 3–6 ☐ 7–10 ☐ 11–13 ☐ 14–18
Secondary user group *(tick all that apply)*	☐ caregivers with strollers ☐ elderly (grandparents) ☐ staff ☐ visitors/community
Sensitivity and coping capacity *(tick all that apply)*	☐ mobility limitation ☐ heat-sensitive condition ☐ sensory sensitivity/neurodiversity ☐ low autonomy (younger age) ☐ other: .....

Vulnerability scoring (0–2)

0 = no flags + older group (14-18 yrs old)
1 = one flag or younger group (7-13 yrs old) and/or frequent presence of strollers/elderly
2 = multiple flags (mobility + heat sensitive, etc.) and/or sensitive group (0-6 yrs old), and/or frequent presence of strollers/elderly

0 = LOW vulnerability
1 = MEDIUM vulnerability
2 = HIGH vulnerability

Your notes:

.....
.....
.....

MACRO scale audit

PART IV - Risk driver assessment

Pathway assessment

Indicator	Question/Evaluation focus	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Urban Heat Island		.....	Max score = 8	0–3 = HIGH UHI risk 4–6 = MEDIUM UHI risk 7-8 = LOW UHI risk	
Shade availability (peak hours)	*Is the route shaded during peak sun/heat hours (12–15) where children walk/wait?*	.....	**0** = mostly unshaded **1** = mixed **2** = mostly shaded	shade walk + photo points	
Tree canopy continuity	*Is canopy continuous (not only isolated trees)?*	.....	**0** = none/isolated **1** = partial **2** = continuous	quick mapping + observation	
Heat-absorbing surfaces	*Are dark/sealed heat-absorbing surfaces dominant along key segments?*	.....	**0** = dominant **1** = mixed **2** = limited/mitigated	surface scan	
Ventilation potential	*Is the route ventilated (not a "hot canyon")?*	.....	**0** = trapped/stagnant **1** = mixed **2** = ventilated/open	urban form reading + field check	
Stormwater Runoff		.....	Max score = 6	0–2 = HIGH Stormwater runoff risk 3–4 = MEDIUM Stormwater runoff risk 5-6 = LOW Stormwater runoff risk	
Surface permeability	*Are permeable surfaces present where runoff accumulates (edges, widened nodes, slopes)?*	.....	**0** = mostly sealed **1** = mixed **2** = mostly permeable/ functional	surface mapping	
Ponding / waterlogging hotspots	*Are there puddles/ponding zones after rain along the walking line?*	.....	**0** = frequent/major **1** = occasional/local **2** = rare/none	post-rain check + staff	
Drainage / retention features	*Are drains/bioswales/rain gardens present and functioning?*	.....	**0** = none **1** = limited/ineffective **2** = present/effective	walkthrough + photo log	
Biotope Loss		.....	Max score = 6	0–2 = HIGH Biotope Loss 3–4 = MEDIUM Biotope Loss 5-6 = LOW Biotope Loss	
Green presence along route	*Is greenery experienced along the walk (tree line/green edge), not only distant parks?*	.....	**0** = low **1** = medium **2** = high	field scan	
Green connectivity	*Is greenery continuous or fragmented along the route?*	.....	**0** = fragmented • **1** = partial **2** = continuous	quick mapping	

MACRO scale audit

PART IV - Risk driver assessment

Pathway assessment

Indicator	Question/Evaluation focus	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Typology diversity	*Are multiple green typologies present (trees + shrubs + planted edges + patches)?*	.....	**0** = mono **1** = some **2** = diverse	scan	
Physical Activity		.....	Max score = 6	0–2 = HIGH Physical inactivity risk 3–4 = MEDIUM Physical inactivity risk 5-6 = LOW Physical inactivity risk	
Walkability continuity	*Is walking comfortable and uninterrupted (sidewalk continuity + safe width)?*	.....	**0** = poor **1** = mixed **2** = good	route walk	
Cycling support	*Are cycling conditions safe/continuous (protected lane or calm street)?*	.....	**0** = none/unsafe **1** = partial **2** = safe/continuous	field check	
Destinations / supports	*Are there supports along/near route (parks, respite points, micro-destinations) that encourage movement?*	.....	**0** = none **1** = some **2** = several	map + scan	
Spatial Inequity		.....	Max score = 6	0–2 = HIGH Spatial inequityy risk 3–4 = MEDIUM Spatial inequity risk 5-6 = LOW Spatial inequity risk	
Sidewalk continuity + effective width	*Is sidewalk continuous and usable for strollers/wheelchairs?*	.....	**0** = many gaps/narrow **1** = mixed **2** = continuous/adequate	checklist + photos	
Barrier-free continuity	*Are curb ramps and step-free transitions continuous (few barriers per km)?*	.....	**0** = many barriers **1** = some **2** = barrier-free	accessibility walk	
Speed context / calming	*Is the route in a calm traffic context (e.g., 30 km/h, calming measures)?*	.....	**0** = fast traffic **1** = mixed **2** = calmed	signage + observation	
Chil development		.....	Max score = 4	1 = HIGH Spatial inequityy risk 2 = MEDIUM Spatial inequity risk 3-4 = LOW Spatial inequity risk	
Autonomy potential (age-adjusted)	*Can children plausibly walk parts independently (visibility, crossings, safety)?*	.....	0 = no 1 = partial 2 = yes	parent/staff input + observation	
Sensory & cognitive stimuli	*Are there child-scale cues (nature, landmarks, murals, textures) supporting engagement?*	.....	0 = low 1 = some 2 = rich	walkthrough	
			Total score		

MACRO scale audit

PART IV - Risk driver assessment

Street corssing assessment

Indicator	Question/Evaluation focus	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Urban Heat Island		.....	Max score = 8	0–3 = HIGH UHI risk 4–6 = MEDIUM UHI risk 7-8 = LOW UHI risk	
Shade availability	*Is the crossing shaded during peak sun/heat hours (12–15) where children walk/wait?*	.....	**0** = mostly unshaded **1** = mixed **2** = mostly shaded	shade walk + photo points	
Heat-absorbing surfaces	*Are dark/sealed heat-absorbing surfaces dominant?*	.....	**0** = dominant **1** = mixed **2** = limited/mitigated	surface scan	
Stormwater Runoff		.....	Max score = 6	0–2 = HIGH Stormwater runoff risk 3–4 = MEDIUM Stormwater runoff risk 5-6 = LOW Stormwater runoff risk	
Ponding / waterlogging hotspots	*Are there puddles/ponding zones after rain along the walking line?*	.....	**0** = frequent/major **1** = occasional/local **2** = rare/none	post-rain check + staff	
Drainage / retention features	*Are drains/bioswales/rain gardens present and functioning?*	.....	**0** = none **1** = limited/ineffective **2** = present/effective	walkthrough + photo log	
Biotope Loss		.....	Max score = 6	0–2 = HIGH Biotope Loss 3–4 = MEDIUM Biotope Loss 5-6 = LOW Biotope Loss	
Green presence along route	*Is greenery experienced along the walk (tree line/green edge), not only distant parks?*	.....	**0** = low **1** = medium **2** = high	field scan	
Green connectivity	*Is greenery continuous or fragmented along the route?*	.....	**0** = fragmented • **1** = partial **2** = continuous	quick mapping	
Typology diversity	*Are multiple green typologies present (trees + shrubs + planted edges + patches)?*	.....	**0** = mono **1** = some **2** = diverse	scan	
Physical Activity		.....	Max score = 6	0–2 = HIGH Physical inactivity risk 3–4 = MEDIUM Physical inactivity risk 5-6 = LOW Physical inactivity risk	
Walkability continuity	*Is walking comfortable and uninterrupted (sidewalk continuity + safe width)?*	.....	**0** = poor **1** = mixed **2** = good	route walk	
Cycling support	*Are cycling conditions safe/continuous (protected lane or calm street)?*	.....	**0** = none/unsafe **1** = partial **2** = safe/continuous	field check	

MACRO scale audit

PART IV - Risk driver assessment

Street corssing assessment

Indicator	Question/Evaluation focus	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Spatial Inequity		.....	Max score = 6	0–2 = HIGH Spatial inequityy risk 3–4 = MEDIUM Spatial inequity risk 5-6 = LOW Spatial inequity risk	
Sidewalk continuity + effective width	*Is sidewalk continuous and usable for strollers/wheelchairs?*	.....	**0** = many gaps/narrow **1** = mixed **2** = continuous/adequate	checklist + photos	
Barrier-free continuity	*Are curb ramps and step-free transitions continuous (few barriers per km)?*	.....	**0** = many barriers **1** = some **2** = barrier-free	accessibility walk	
Speed context / calming	*Is the route in a calm traffic context (e.g., 30 km/h, calming measures)?*	.....	**0** = fast traffic **1** = mixed **2** = calmed	signage + observation	
Chil development		.....	Max score = 4	1 = HIGH Spatial inequityy risk 2 = MEDIUM Spatial inequity risk 3-4 = LOW Spatial inequity risk	
Autonomy potential (age-adjusted)	*Can children plausibly walk parts independently (visibility, crossings, safety)?*	.....	0 = no 1 = partial 2 = yes	parent/staff input + observation	
Sensory & cognitive stimuli	*Are there child-scale cues (nature, landmarks, murals, textures) supporting engagement?*	.....	0 = low 1 = some 2 = rich	walkthrough	
			Total score		

MACRO scale audit

PART IV - Risk driver assessment

Transit stops assessment

Indicator	Question/Evaluation focus	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Urban Heat Island		.....	Max score = 8	0–3 = HIGH UHI risk 4–6 = MEDIUM UHI risk 7-8 = LOW UHI risk	
Shade availability	*Is the waiting are shaded during peak sun/heat hours (12–15)?*	.....	**0** = mostly unshaded **1** = mixed **2** = mostly shaded	shade walk + photo points	
Heat-absorbing surfaces	*Are dark/sealed heat-absorbing surfaces dominant?*	.....	**0** = dominant **1** = mixed **2** = limited/mitigated	surface scan	
Stormwater Runoff		.....	Max score = 6	0–2 = HIGH Stormwater runoff risk 3–4 = MEDIUM Stormwater runoff risk 5-6 = LOW Stormwater runoff risk	
Rain protection + dry waiting	*Is there shelter from rain + surfaces that stay usable (not drenched)?*	.....	0 = no 1 = partial 2 = good	observation	
Ponding / waterlogging hotspots	*Does the water pool where people board/wait?*	.....	**0** = frequent/major **1** = occasional/local **2** = rare/none	post-rain check + staff	
Drainage / retention features	*Are drains/bioswales/rain gardens present and functioning?*	.....	**0** = none **1** = limited/ineffective **2** = present/effective	walkthrough + photo log	
Biotope Loss		.....	Max score = 6	0–2 = HIGH Biotope Loss 3–4 = MEDIUM Biotope Loss 5-6 = LOW Biotope Loss	
Green presence along route	*Is there greenery close the stops (tree line/green edge), buffering traffic and supporting comfort?*	.....	**0** = none **1** = some **2** = a lot	field scan	
Green connectivity	*Is greenery continuous or fragmented along the route?*	.....	**0** = fragmented **1** = partial **2** = continuous	quick mapping	
Typology diversity	*Are multiple green typologies present (trees + shrubs + planted edges + patches)?*	.....	**0** = mono **1** = some **2** = diverse	scan	
Physical Activity		.....	Max score = 6	0–2 = HIGH Physical inactivity risk 3–4 = MEDIUM Physical inactivity risk 5-6 = LOW Physical inactivity risk	
Walkability continuity	*Is there a continuous safe path to the stop (sidewalk/bike)?*	.....	**0** = no **1** = partial **2** = yes	route walk	

MACRO scale audit

PART IV - Risk driver assessment

Transit stops assessment

Indicator	Question/Evaluation focus	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Spatial Inequity		.....	Max score = 6	0–2 = HIGH Spatial inequityy risk 3–4 = MEDIUM Spatial inequity risk 5-6 = LOW Spatial inequity risk	
Sidewalk continuity + effective width	*Is sidewalk and access to the stop continuous and usable for strollers/wheelchairs?*	.....	**0** = many gaps/narrow **1** = mixed **2** = continuous/adequate	checklist + photos	
Barrier-free continuity	*Are curb ramps and step-free transitions continuous (zero barriers)?*	.....	**0** = many barriers **1** = some **2** = barrier-free	accessibility walk	
Maneuvering space	*Is there enough clear space to wait/turn (stroller/wheelchair)?*	.....	**0** = no **1** = partial **2** = yes	signage + observation	
Seating quality	*Are seating present, usable, and accessible (some with back/arm)?*	.....	**0** = none **1** = limited **2** = adequate	observation	
Lighting and perception of safety	*Is the stop well-lit and feels safe for children/caregivers?*	.....	**0** = none **1** = limited **2** = adequate	observation	
Chil development		.....	Max score = 4	1 = HIGH Spatial inequityy risk 2 = MEDIUM Spatial inequity risk 3-4 = LOW Spatial inequity risk	
Autonomy potential (age-adjusted)	*Can children plausibly walk parts independently (visibility, crossings, safety)?*	.....	0 = no 1 = partial 2 = yes	parent/staff input + observation	
Sensory & cognitive stimuli	*Are there child-scale cues (nature, landmarks, murals, textures) supporting engagement?*	.....	0 = low 1 = some 2 = rich	walkthrough	
Wayfinding	*Is the information readable and child-friendly (icons/maps/clarity)?*	.....	**0** = poor **1** = adequate **2** = good	observation	
			Total score		

1, 2, 3...

... start

You are looking for safe arrival, legible access, bottlenecks, microclimate stress, and "first/last 30 m" problems.

1) Prepare (15 min)

- Base map of boundary line (fence / wall / property line)
- Mark gate(s), main entrance, service access, bike parking
- Confirm audit time window + weather note (last 24–48h)
- Decide scope: Threshold / Gate / Entrance forecourt / Perimeter edge

2) Observe / scan (45–90 min)

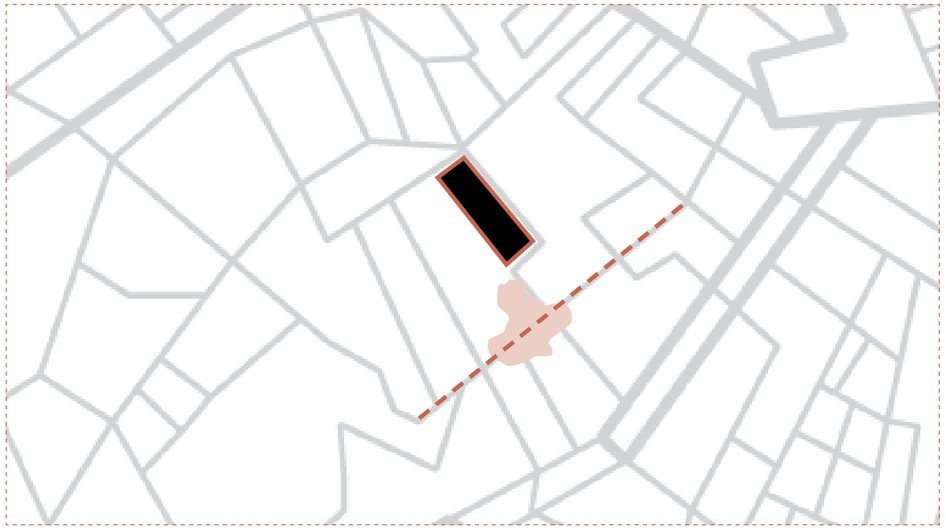
- Trace arrival sequences (walkers, bikes, strollers, special needs access)
- Identify queue and waiting zones (where people actually stand)
- Mark conflict points (cars vs pedestrians, crossings at gate, turning radii)
- Check accessibility continuity (ramps, curb cuts, tactile cues, widths)
- Note microclimate exposure at the edge (sun trap, no shade, wind tunnel, rain runoff)
- Record visibility & supervision (sightlines, lighting, blind corners, perceived safety)

3) Output (10 min)

- One annotated map: arrival chain & nodes (gate/door/queue spots)
- A short list of priority hotspots (max 5) + quick wins
- Photo log (min 10 photos) with location tags (gate, queue, ramps, shade, runoff)

MESO scale audit

Assesing school access system in the neighbourhood (routes + crossings + transit stops)



Context & identifiers

Municipality / neighbourhood: .....
School name: .....
Address: .....
Coordinates: .....
Urban context: .....
School level: .....
Students age range: .....
Number of students: .....
Yard area assessed: .....
Constraints / restrictions: .....

Date + time window observed: .....
Weather note (heat / rain in last 24–48h): .....
Auditors: .....

MESO scale audit

PART II - Exposure profile

? *How often, how long, and where children spend time in the schoolyard, and whether that time coincides with peak sun / rain.*

Exposure indicator	Question / evaluation focus	Score (0–2)	Scoring guide	Method
Use intensity at threshold	*Is the entrance/forecourt used daily by many users (arrival + dismissal)?*	.....	**0** = rarely **1** = moderate **2** = very frequent/crowded	Timetable + peak-time observation
Peak-condition exposure	*Are children outside at the threshold during 12–15 (hot season) and/or during heavy rain events?*	.....	**0** = rarely **1** = sometimes **2** = often	Timetable + staff
Duration of waiting	*Do children/caregivers wait at the entrance/forecourt (queues, delays, pick-up)?*	.....	**0** = short **1** = medium **2** = long	Observation + staff
Spatial concentration in exposed spots	*Is waiting concentrated in the most exposed area (full sun, hardscape, ponding routes, traffic edge)?*	.....	**0** = avoided **1** = mixed **2** = concentrated	Mapping during peak time
Traffic-related exposure at gate	*Is there regular exposure to idling cars / drop-off conflict, and do users stand close to it?*	.....	**0** = minimal **1** = some **2** = strong	Observation + quick traffic note
			Maximum score = 10 0–3 = LOW Exposure 4–6 = MEDIUM Exposure 7–10 = HIGH Exposure	

MESO scale audit

PART III - Vulnerability profile

User indicator	Data
Primary user group *(pick one, maximum two)*	☐ 3–6 ☐ 7–10 ☐ 11–13 ☐ 14–18
Secondary user group *(tick all that apply)*	☐ caregivers with strollers ☐ elderly (grandparents) ☐ staff ☐ visitors/community
Sensitivity and coping capacity *(tick all that apply)*	☐ mobility limitation ☐ heat-sensitive condition ☐ sensory sensitivity/neurodiversity ☐ low autonomy (younger age) ☐ other: .....

Vulnerability scoring (0–2)

0 = no flags + older group (14-18 yrs old)
1 = one flag or younger group (7-13 yrs old) and/or frequent presence of strollers/elderly
2 = multiple flags (mobility + heat sensitive, etc.) and/or sensitive group (0-6 yrs old), and/or frequent presence of strollers/elderly

0 = LOW vulnerability
1 = MEDIUM vulnerability
2 = HIGH vulnerability

Your notes:

.....

.....

.....

MESO scale audit

PART IV - Risk driver assessment

Indicator	Question/Evaluation focus	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Urban Heat Island		.....	Max score = 8	0–3 = HIGH UHI risk 4–6 = MEDIUM UHI risk 7-8 = LOW UHI risk	
Shade at exits and waiting areas (peak hours)	Is there adequate shade for people queuing/waiting at the entrance and along the interface?	.....	**0** = mostly unshaded **1** = mixed **2** = mostly shaded	shade walk + photo points	
Tree canopy cover	*Is canopy present and continuous (not only isolated trees)?*	.....	**0** = none/isolated **1** = partial **2** = continuous	quick mapping + observation	
Heat-absorbing materials at forecourt/interface	*Are hardscape surfaces at thresholds dark/sealed/hot, or light colored (high albedo / refectivity)?*	.....	**0** = mostly dark **1** = mixed **2** = mostly light	squick mapping + observation	
Façade solar exposure risk (orientation + glazing + reflectivity)	*Does the envelope amplify heat at the edge (high glazing, dark façade colors)?*	.....	**0** = high risk **1** = moderate **2** = low risk	Sun-path analysis, observation	
Façade shading devices	*Are there effective façade shading devices on exposed orientations?*	.....	**0** = trapped/stagnant **1** = mixed **2** = ventilated/open	urban form reading + field check	
Vegetated shading (vines/screens/green edge)	*Is there meaningful vertical/edge greening that provides shading/cooling?*	.....	**0** = none **1** = limited **2** = meaningful	Observation	
Stormwater Runoff		.....	Max score = 6	0–2 = HIGH Stormwater runoff risk 3–4 = MEDIUM Stormwater runoff risk 5-6 = LOW Stormwater runoff risk	
Rain buffering for arrival routes	*Are the key approach paths covered/protected enough to keep access usable in the rain?*	.....	**0** = no **1** = partialy/ineffective **2** = yes/effective	Observation, staff interviews	
Drainage at thresholds (doors + gate areas)	*Do thresholds have functional drainage (grates/strips) and no recurring pooling?*	.....	**0** = none **1** = partial **2** = functional	observation, inspection	
Ponding / waterlogging hotspots	*Are there puddles/ponding zones after rain along the entrance/waiting area?*	.....	**0** = frequent/major **1** = occasional/local **2** = rare/none	post-rain check, staff interviews	
Infiltration zones/tree pits at the forecourt	*Are there areas of infiltration where runoff concentrates?*	.....	**0** = none **1** = limited/ineffective **2** = present/effective	observation, inspection, post-rain check	
Drainage / retention features	*Are drains/bioswales/rain gardens present and functioning at the entrance/along the school building?*	.....	**0** = none **1** = limited/ineffective **2** = present/effective	observation	

Indicator	Question/Evaluation focus	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Roof retention/harvesting	*Is roof water managed (green roof and/or water harvesting)?*	.....	**0** = none **1** = one element **2** = meaningful capacity	observation	
Biotope Loss		.....	Max score = 6	0–2 = HIGH Biotope Loss 3–4 = MEDIUM Biotope Loss 5-6 = LOW Biotope Loss	
Green presence at the entry/ tresholds	*Is there multilayer vegetation (ground/shrub/tree), not just pots or isolated trees?*	.....	**0** = minimal **1** = some **2** = multilayer	observation	
Green connectivity	*Is greenery continuous or fragmented?*	.....	**0** = fragmented • **1** = partial **2** = continuous	observation	
Typology diversity	*Are multiple green typologies present (trees + shrubs + planted edges + patches)?*	.....	**0** = mono **1** = some **2** = diverse	observation	
Envelope greening	*Are green roofs/walls/screens and/or habitat features integrated?*	.....	**0** = none **1** = partail **2** = meaningful	observation	
Physical Activity		.....	Max score = 6	0–2 = HIGH Physical inactivity risk 3–4 = MEDIUM Physical inactivity risk 5-6 = LOW Physical inactivity risk	
Active travel amenities	*Are bike/scooter facilities present and adequate (capacity + usability)?*	.....	**0** = none **1** = limited **2** = adequate	observation	
Playable waiting environment	*Does the entrance/forecourt include micro-activity prompts and seating (turn waiting into light movement)?*	.....	**0** = none **1** = partial **2** = adequate	observation	
Direct access to movement space	*Do children have direct, legible transitions from building clusters to outdoor activity zones?*	.....	**0** = poor **1** = partial **2** = strong	observation	
Spatial Inequity		.....	Max score = 6	0–2 = HIGH Spatial inequityy risk 3–4 = MEDIUM Spatial inequity risk 5-6 = LOW Spatial inequity risk	
Inclusive wayfinding + tactile/contrast cues	*Are signage, contrast, and tactile cues adequate for navigation, including neurodiversity/visual impairment?*	.....	**0** = none **1** = partial **2** = clear	observation	

MESO scale audit

PART IV - Risk driver assessment

Indicator	Question/Evaluation focus	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Barrier-free entry	*Is the entrance step-free and barrier-free (including width, slopes, obstacles)?*	.....	**0** = many barriers **1** = some **2** = barrier-free	observation	
Safe waiting + drop-off conflict management	*Are waiting zones protected from traffic and conflict points managed at peak times?*	.....	**0** = no **1** = limited **2** = yes	observation	
			Total score		

MESO scale audit

PART V - Child development support assessment

Indicator	Question/Evaluation focus	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Child development		.....	**Max score = 6**	0–2 = HIGH Spatial inequityy risk 3–4 = MEDIUM Spatial inequity risk 5-6 = LOW Spatial inequity risk	
Indicator	**What to check (prompt)**	**Score (0–2)**	**Scoring guide**	**Methods**	**Synergies & Tradeoffs**
Child-friendly markers and belonging	*Are there child-visible, culturally relevant markers (murals, cues, school identity) that support recognition & belonging?*	.....	**0** = none **1** = some **2** = meaningful & maintained	observation	
Visibility and access to outdoor spaces	*Are outdoor spaces visible and easily reachable (direct exits, visual connection)?*	.....	**0** = no **1** = partialy **2** = yes	observation	
Outdoor views from classrooms	*Do learning spaces have views to green/play zones (supporting regulation/attention)?*	.....	**0** = limited **1** = mixed **2** = widespread	observation	
Façade-integrated learning elements	*Are there façade/wall elements that support playful learning (signage, measurement marks, murals)?*	.....	**0** = none **1** = limited **2** = present	observation	
Direct exits supporting autonomy	*Do classroom clusters have direct exits that support flexible indoor–outdoor routines?*	.....	**0** = none **1** = limited **2** = present	observation	

1, 2, 3...

... start

You are looking for comfort, safe surfaces, activity + calm affordances, drainage logic, and "where kids avoid / get stuck" problems.

1) Prepare (15 min)

- Base map of boundary line (fence / wall / property line)
- Yard plan (or quick sketch) + main doors + circulation lines
- Mark program zones (play / sport / calm / learning / service)
- Confirm audit time window + weather note (last 24–48h)
- Decide scope: whole yard or priority zones (e.g., entrance yard, main play, quiet area)

2) Observe / scan (45–90 min)

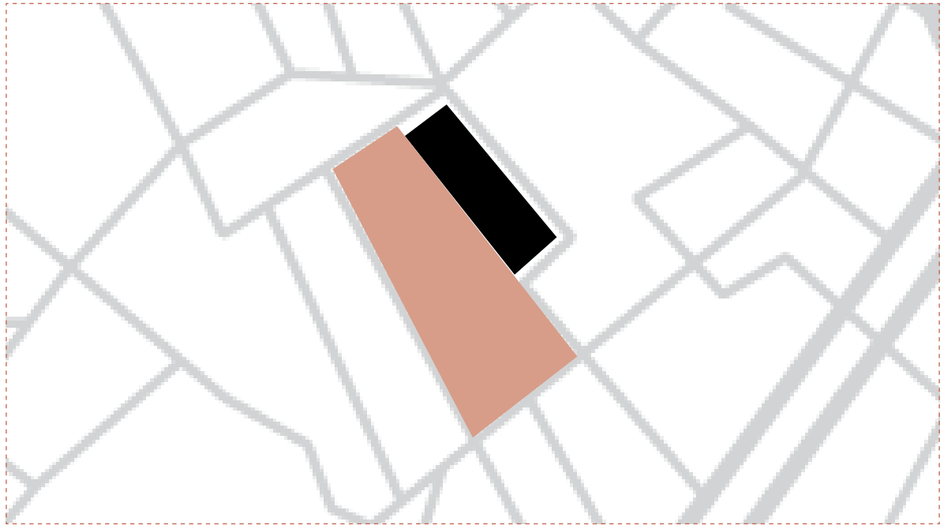
- Trace actual use patterns (movement loops, congregations, avoided areas)
- Identify thermal stress zones (no shade, hot surfaces, radiant traps, lack of seating comfort)
- Check ground performance (slip, glare, overheating, permeability, puddling/erosion traces)
- Map shade + refuge network (trees/canopies + "cool down" spots + water access if any)
- Assess affordances (movement variety, loose parts, social spaces, calm niches, inclusive play)
- Verify universal access (step-free routes, ramps, reachable seating, inclusive equipment)
- Note maintenance failure modes (clogged drains, broken shade, compacted soil, worn surfaces)

3) Output (10 min)

- One annotated plan: zones + hotspots + refuge points
- A short list of priority hotspots (max 5) + quick wins
- Photo log (min 15 photos) with location tags (shade, surfaces, seating, drainage, play/calm zones)

MICRO scale audit

Assesing the schoolyard.



Context & identifiers

Municipality / neighbourhood: .....
School name: .....
Address: .....
Coordinates: .....
Urban context: .....
School level: .....
Students age range: .....
Number of students: .....
Yard area assessed: .....
Constraints / restrictions: .....

Date + time window observed: .....
Weather note (heat / rain in last 24–48h): .....
Auditors: .....

MICRO scale audit

PART II - Exposure profile

? *How often, how long, and where children spend time in the schoolyard, and whether that time coincides with peak sun / rain.*

Exposure Indicator	Question / evaluation focus	Score (0-2)	Scoring guide (0/1/2)	Methodology / data source
Use intensity	*Is the space used regularly by multiple groups?*	.....	**0** = not used/rarely accessed **1** = occasionally used (limited times/groups) **2** = frequently used (daily/regularly by multiple groups)	short survey + walkthroughs + interviews
Peak-condition exposure	*Are children outside during peak sun/heat hours (12-15)?*	.....	**0** = rarely **1** = sometimes **2** = often	timetable + staff
Spatial concentration in exposed zones	*Is the use concentrated in the most exposed places (full sun / ponding routes)?*	.....	**0** = mostly avoided **1** = mixed **2** = concentrated	short survey + walkthroughs + interviews
Duration	*How much time typically children spend outdoors per day (in this yard)?*	.....	**0** = short **1** = medium **2** = long	timetable + staff
Seasonal usability *[optional - contextual info - not scored]*	*Is the space usable across seasons and peak hours (heat/wind/rain)?*	**Season**	**Time**	
		Spring	☐ 8–10 ☐ 10–12 ☐ 12–14 ☐ 14–16 ☐ 16–18	
		Summer	☐ 8–10 ☐ 10–12 ☐ 12–14 ☐ 14–16 ☐ 16–18	
		Autumn	☐ 8–10 ☐ 10–12 ☐ 12–14 ☐ 14–16 ☐ 16–18	
		Winter	☐ 8–10 ☐ 10–12 ☐ 12–14 ☐ 14–16 ☐ 16–18	
			Max score = 8 0–2 = LOW Exposure 3–5 = MEDIUM Exposure 6–8 = HIGH Exposure	
Additional exposure stressors [optional, not scored]				
Air quality (perceived)	*Describe the outdoor air quality at the schoolyard during a typical day (based on visibility, odors, nearby traffics, etc.). Are there obvious pollution sources affecting outdoor use?*		**0** = poor (obvious sources; exhaust smell/smoke/dust; outdoor use constrained) **1** = moderate (some sources; occasional odor/traffic influence) **2** = good (no obvious sources; outdoor use not constrained)	visual observation + olfactory perception
Noise quality (perceived)	*Describe the typical sound environment of the schoolyard during the day (besed on background noise, nearby traffic, mechanical sounds, etc.).*		**0** = poor (traffic/mechanical noise dominates; hard to stay/teach outside) **1** = moderate (periodic peaks; outdoor use possible but limited) **2** = good (generally calm; outdoor use not constrained)	subjective observation on environmental context

MICRO scale audit

PART III - Vulnerability profile

User indicator	Data
Primary user group *(pick one, maximum two)*	☐ 3–6 ☐ 7–10 ☐ 11–13 ☐ 14–18
Secondary user group *(tick all that apply)*	☐ caregivers with strollers ☐ elderly (grandparents) ☐ staff ☐ visitors/community
Sensitivity and coping capacity *(tick all that apply)*	☐ mobility limitation ☐ heat-sensitive condition ☐ sensory sensitivity/neurodiversity ☐ low autonomy (younger age) ☐ other: .....

Vulnerability scoring (0–2)

0 = no flags + older group (14-18 yrs old)
1 = one flag or younger group (7-13 yrs old)
and/or frequent presence of strollers/elderly
2 = multiple flags (mobility + heat sensitive, etc.)
and/or sensitive group (0-6 yrs old),
and/or frequent presence of strollers/elderly

0 = LOW vulnerability
1 = MEDIUM vulnerability
2 = HIGH vulnerability

Your notes:

.....
.....
.....

MICRO scale audit

PART IV - Risk driver assessment

Indicator	Question / evaluation focus	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Urban Heat Island			Max score = 12	0–4 = HIGH UHI risk 5–8 = MEDIUM UHI risk 9-12 = LOW UHI risk	
Microclimatic exposure (yard geometry + solar exposure)	*Is the yard's form/massing likely to create overexposure (full sun all day) or trapped heat (poor air exchange)?*		**0** = closed/no air movement; exposed to sun all day **1** = moderately exposed but still large overheated zones or weak balance **2** = geometry supports balanced sun/shade and airflow	wind data, site orientation, W/H reasoning, sun observation	
Shade availability (peak hours)	*Is there effective shade over main play/rest/learning areas during hot hours?*		**0** = **minimal/none:** shade absent in key play/rest/learning areas; no meaningful tree shade or structures **1** = **partial/patchy:** shade exists but is discontinuous, badly located, or only at certain times; mainly small trees or isolated canopies **2** = **adequate & well placed:** shade covers key zones during peak hot hours; mix of **tree canopy + shade structures** is well located	shade walk / surface mapping	
Radiant heat from heat- absorbing ground surfaces	*Are dark/sealed heat-absorbing surfaces dominant in use areas?*		**0** = dominant **1** = mixed **2** = limited + mitigated (shade/cool materials)	surface mapping	
Radiant heat from adjacent façades (finish + distance)	*Do nearby façades contribute to radiant heat load in main use zones? Assessment of facade color/finish (radiant heat) and proximity (adjacency) to schoolyard*		**0** = **high:** dark / heat-absorbing façades close to key zones; strong radiant exposure likely **1** = **moderate:** mixed finishes or partial separation/buffering **2** = light/high-reflective finishes or sufficient setback + buffering (vegetation, shaded edge)	observation, surface mapping	
Cooling elements	*Are there "cooling supports" (trees, evapotranspiration zones, water point)?*		**0** = **absent:** no trees/ evapotranspiration zones/water access **1** = **limited:** some trees/green but not functional for cooling (small canopy, too few, badly placed), or water point not usable **2** = **present & functional:** canopy + green areas meaningfully cool key zones; water point works	inventory, surface mapping	
Ventilation / air movement	*Is the yard able to ventilate (not a stagnant hot bowl)?*		**0** = stagnant/ blocked **1** = partial **2** = good airflow potential	simple wind logic + observation	
Stormwater Runoff			Max score = 6	0–2 = HIGH Stormwater runoff risk 3–4 = MEDIUM Stormwater runoff risk 5-6 = LOW Stormwater runoff risk	
Surface permeability	*Is permeable ground present where it matters*		**0** = mostly impermeable **1** = mixed	surface mapping	

MICRO scale audit

PART IV - Risk driver assessment

Indicator	Question / evaluation focus	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Stormwater Runoff			Max score = 6	0–2 = HIGH Stormwater runoff risk 3–4 = MEDIUM Stormwater runoff risk 5-6 = LOW Stormwater runoff risk	
Surface permeability	*Is permeable ground present where it matters (use zones + drainage paths)?*		**0** = mostly impermeable **1** = mixed **2** = mostly permeable / functional infiltration	surface mapping	
Ponding / waterlogging	*After rain, do puddles/ponding zones appear in use routes/areas?*		**0** = frequent/major **1** = occasional/local **2** = rare/none	post-rain check + staff input	
Drainage / retention features	*Are there basic runoff controls (swales, drains, rain gardens, tree pits)?*		**0** = none **1** = few/ineffective **2** = present & effective	walkthrough	
Biotope Loss			Max score = 8	0–3 = HIGH Biotope Loss 4–5 = MEDIUM Biotope Loss 7-8 = LOW Biotope Loss	
Presence of Plant Layers	*Are there multiple vegetation layers (trees, shrubs, and soil-covering plants/flowers), not just lawn or isolated trees?*		**0** = single/no planting present **1** = only one layer present (e.g., shrubs or lawn) **2** = multiple layers present (trees + shrubs + groundcover)	quick ecological scan	
Plant diversity (sensory + ecological)	*Is vegetation diverse (species/seasonality/size/colour/ fragrance/ texture), not monoculture?*		**0** = very low (< 3 species present) **1** = moderate (≥3 small / ≥5 large-yard varieties) **2** = high diversity (≥5 shrub/plant varieties across layers)	quick inventory	
Living soil/ permeable green	*Is there living soil/plantable ground (not only pots/turf)?*		**0** = minimal **1** = some **2** = meaningful		
Habitat features	*Are there habitats/micro-habitats (logs, insect hotels, birdhouses, deadwood, compost)?*		**0** = none **1** = some (1–2 types) **2** = multiple types (≥3 types)	inventory	
Physical Activity			Max score = 8	0–2 = HIGH Physical inactivity risk 3–4 = MEDIUM Physical inactivity risk 5-6 = LOW Physical inactivity risk	
Space for varied play	*Is there enough flexible open space usable for varied play (not just leftover asphalt)?*		**0** = lacking/unusable **1** = some **2** = adequate & usable	plan + observation	
Movement affordance variety	*Are there diverse movement options (run/climb/balance/roll/etc.)?*		**0** = very limited **1** = some **2** = rich & distributed	affordance scan	

MICRO scale audit

PART IV - Risk driver assessment

Indicator	Question / evaluation focus	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Movement loop / paths	*Is there a loop/path enabling active circulation/games?*	.....	**0** = none **1** = partial **2** = clear loop/circuit	quick map	
Inclusion in movement	*Does the space support a variety of activities for different users (age/gender/ability/ needs)?*	.....	**0** = zero functions or monofunctional: dominated by one activity (e.g., football field) **1** = partially diversified: presence of one dominant use but some smaller zones or elements offering alternative or complementary activities **2** = multifunctional and inclusive: diverse activity zones coexist, providing opportunities for play, rest, learning, and social interaction for different users	short survey + walkthroughs + interviews	
Spatial Inequity		.....	Max score = 6	0–2 = HIGH Spatial inequityy risk 3–4 = MEDIUM Spatial inequity risk 5-6 = LOW Spatial inequity risk	
Step-free access to key zones	*Can all users reach main zones step-free (paths, entries, water, seating)?*	.....	0 = major barriers 1 = partial access 2 = step-free access throughout	accessibility walk	
Distribution of comfort supports	*Are shade/seating/water/calm areas distributed fairly?*	.....	0 = clustered/ unequal 1 = somewhat distributed 2 = well distributed	map comfort points	
Safety + passive supervision	*Are there blind spots/conflict zones that reduce equitable use (especially for younger/girls)?*	.....	0 = many 1 = some 2 = good visibility & legibility	staff input + walk	

MICRO scale audit

PART V - Child development support

Indicator	What to check (prompt)	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Motor development & graded challenge	*Are there opportunities for gross motor development with a gradient of challenge (easy → harder) and safe landing/surfaces?*	.....	**0** = very limited; mostly flat/monotone; no climb/balance/jump variety **1** = some opportunities but limited types or concentrated in one spot **2** = multiple movement types + graded challenge distributed across the yard.	affordance scan + quick map	
Fine-motor + constructive play	*Are there places/materials for fine-motor / making / manipulating (sand, loose parts, small-build areas, drawing, nature materials)?*	.....	**0** = absent **1** = present but limited/non-functional (locked away, too little, poor setup) **2** = present, accessible, and usable in daily routines.	inventory + staff input	
Cognitive & learning affordances outdoors	*Are there usable outdoor learning nodes (tables/pergola/circle/wall boards) + prompts for exploration (nature signage, measurement marks, playable learning)?*	.....	**0** = none **1** = limited or not really usable (no shade, no seating, no defined node) **2** = clear, comfortable learning nodes + small learning cues integrated.	walkthrough + node count	
Social interaction & cooperative play	*Does the layout support small-group gathering, cooperative play, and multiple social "micro-settings" (not just one big field)?*	.....	**0** = mainly one dominant setting; conflict-prone; few social places **1** = some social spots but limited variety/capacity **2** = several social settings (small/medium) + spaces that reduce conflict and support inclusion.	observation + mapping social spots	
Emotional regulation & retreat	*Is there at least one calm retreat (shade + partial enclosure + seating) that supports self-regulation and decompression?*	.....	**0** = none **1** = limited (exists but exposed/no seating/no comfort) **2** = present, comfortable, and clearly usable (not "leftover corner").	walkthrough	
Sensory richness & nature contact	*Is there multi-sensory input (plants, textures, smells, seasonal change, natural materials, water contact where safe)?*	.....	**0** = low sensory variety; mostly hard surfaces **1** = moderate (some nature, but limited diversity or not accessible) **2** = high sensory variety integrated across zones.	quick ecological + sensory scan	
Nature play / loose parts	*Are there natural materials or loose parts enabling imaginative, sensory play?*	.....	**0** = absent **1** = limited **2** = present & safe	inventory	
Autonomy & legibility at child scale	*Can children navigate and choose spaces (clear paths/loops, landmarks, visibility, child-scale cues, safe "independent zones")?*	.....	**0** = confusing layout/unclear boundaries; adults control movement **1** = partially legible; autonomy possible only in parts **2** = legible layout + cues/landmarks; autonomy supported without compromising safety.	quick map + staff input	

MICRO scale audit

PART V - Child development support

Child development

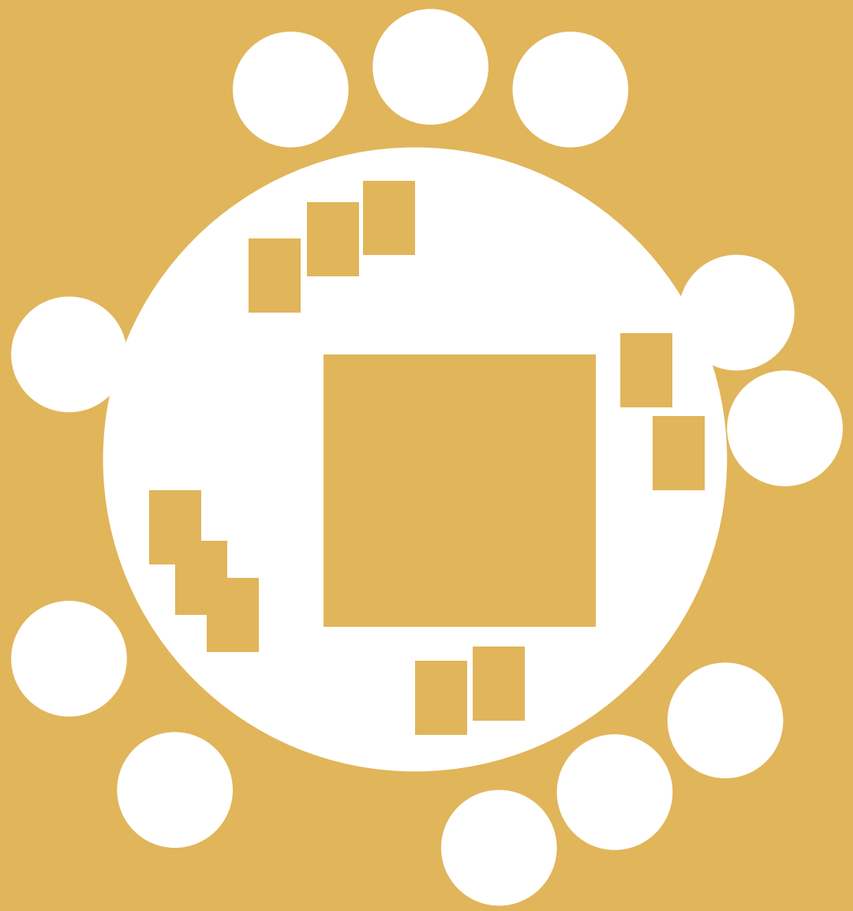
Max score = 18

0–6 = HIGH Spatial inequityy risk
7–12 = MEDIUM Spatial inequity risk
13-18 = LOW Spatial inequity risk

Indicator	What to check (prompt)	Score (0–2)	Scoring guide	Methods	Synergies & Tradeoffs
Inclusive participation across abilities/genders/ages	*Do the main play/learning/rest settings enable participation for different abilities and social groups (not just access)?*	.....	**0** = strong exclusion patterns likely (mono-activity, inaccessible, no alternatives) **1** = some inclusive options, but limited or segregated **2** = inclusive choices embedded across zones; alternatives exist without "othering".	Observation + accessibility walk	

This page is intentionally left blank.

REACTIVE
Co-Design kit



REACTIVE Co-Design Kit for participatory climate & health mapping

As the climate crisis increasingly impacts children's health, well-being, and daily experiences in school environments, it becomes essential to involve those most affected –children, educators, caregivers, and communities – in the planning and design of adaptive solutions. This chapter introduces the REACTIVE Co-Design Kit, a participatory toolkit developed to both analyze the current conditions of school and neighborhood environments and build capacity around the intersection of climate change, urban design, and child development.

The kit is structured as a collaborative mapping game that uses familiar tools such as satellite maps, illustrated persona cards, risk drivers, and solution card decks. The approach combines hands-on spatial investigation with educational storytelling, ensuring that users of different ages and backgrounds can engage meaningfully in identifying challenges and co-creating ideas.

Each element of the toolkit serves a dual purpose:

- to educate participants on climate-health-development risks
- to elicit locally grounded knowledge and preferences.

Co-design session agenda

This section presents a sample agenda for a 90-minute co-design session tailored for schools. The structure is modular and adaptable, allowing facilitators to adjust the session according to the age group, context, and available time. The goal is to engage participants in identifying risks, exploring their impacts on health and development, and generating creative, place-based solutions. The activities draw on the REACTIVE Co-Design Kit, which is designed for use in diverse formats, from classroom settings and professional workshops to walk-along audits with community members.

Example of 90-minute agenda.

Phase	Duration	Activity	Purpose
1. Introduction & Warm-Up	10 min	Present the satellite map and persona cards; ask participants to choose the persona they relate to or want to support.	Set the scene; center users and developmental needs.
2. Risk Exploration	25 min	Use Risk Cards to analyze the site using a traffic-light system (green/yellow/red chips); mark areas on the map.	Identify problem zones through the lens of climate-health risks.
3. Health & Development Link	10 min	Short facilitator input explaining how each risk affects children's health and development.	Deepen understanding of invisible risks and trade-offs.
4. Solution Generation	25 min	Use Solution Cards and idea flags to match risks to ideas; place them on the map.	Move from diagnosis to creative design.
5. Mini-Pitch & Voting	15 min	Groups present one idea each; vote using stickers.	Prioritize actions and build consensus.
6. Wrap-Up	5 min	Reflect, document outcomes, and explain how results will be used in the planning process.	Foster ownership and transparency.

The REACTIVE Co-Design Kit is intentionally modular, adaptable for:

- classroom-based learning,
- professional co-design workshops,
- strategy and policy alignment work sessions,
- walk-along audits with community members.

In the following section, each toolkit component is described in detail, including its content, visual style, and suggested adaptations for different user groups.

Co-design kit components

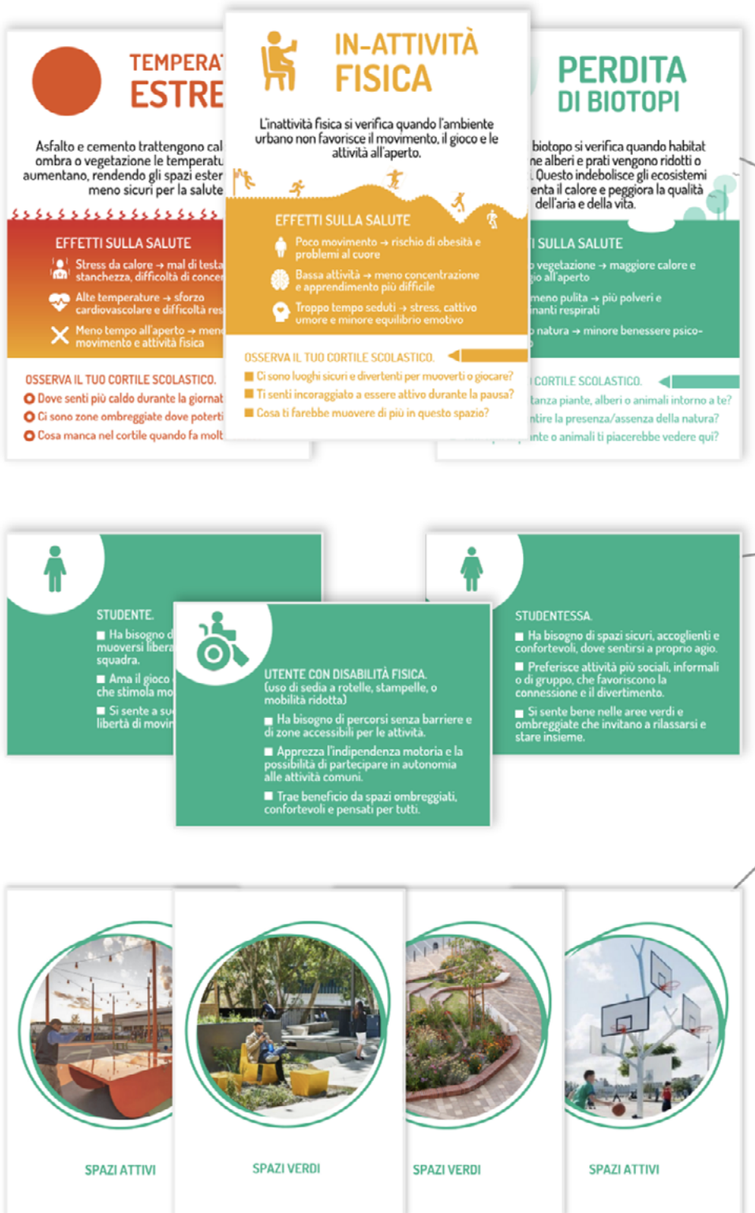
This section outlines the core components of the REACTIVE Co-Design Kit. Each element is designed to promote inclusive participation, raise awareness of climate-health-development risks, and facilitate site-specific knowledge collection. The components, ranging from satellite maps to interactive card decks, are intentionally modular and adaptable to different user groups and facilitation contexts. The following table provides a detailed overview of each item, including its purpose, content, and options for age-appropriate adaptation.

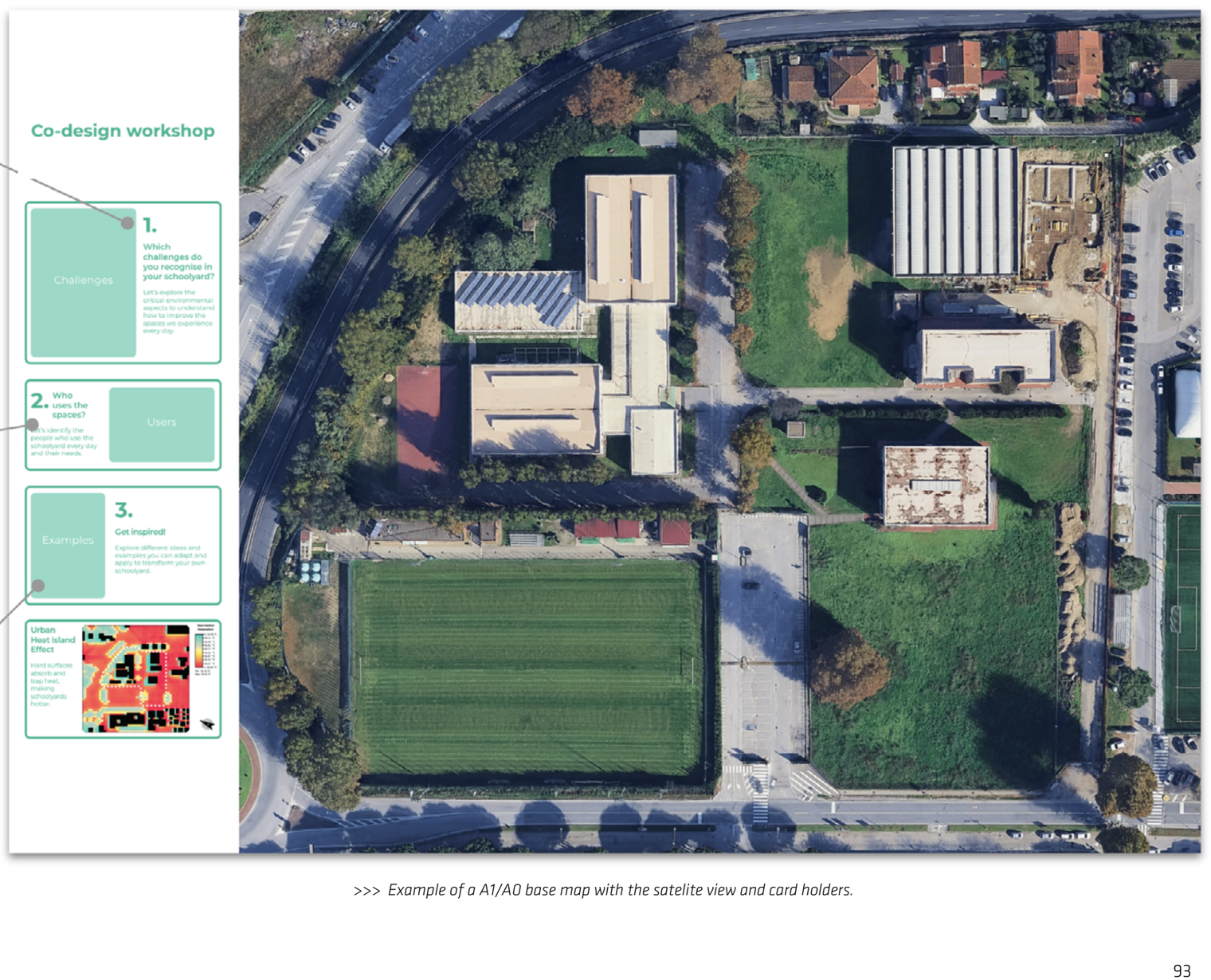
REACTIVE co-design kit components

Component	What it is?	Why it matter?	Variants / Age adaptation
Base map (Satellite)	Large-format aerial print (format A0) of school + 200 m buffer	Gives everyone a shared, scale-accurate canvas for "reading" space and plotting ideas.	Colour-coded layers (buildings, trees, asphalt) pre-printed for younger groups; blank for teens/adults.
User Persona Cards (A6 format)	Card set includes **primary user** such as **students** (male, female, non binaru studnets), **staff** (teachers, administrators, maintenance); **vulnerable users** including persons with physical and/or sensory disability and neurodiverse person. The secondary set of cards, includes **indirect users** such as **community**, **elderely**, **mother with strollers**. Each card includes a silhouette, a brief description of the daily routine, mobility pattern, and key needs.	Keeps the discussion centered on real, diverse users and makes visible the physical, emotional, and developmental needs of children and vulnerable groups.	Younger participants receive simplified persona versions with icons only; older users get full-text cards with developmental & health annotations.
Risk driver Cards*	One card per lens*: • Extreme temperatures • Extreme precipitations • Biotope Loss • Physical Inactivity • Spatial Inequity Each card includes a short description, helath implications, and three guding questions for observation.	Builds shared vocabulary and raises awareness of climate-related risks and health impacts.	Children receive simplified versions with icon summaries and comic visuals.
Solution Cards	Cards presenting nature-based, technical, and play/inclusion solutions (e.g., rain gardens, shaded benches, nature play mounds).	Makes problem-solving visual and hands-on. Allows for quick matching between risks to feasible ideas.	Children use the visual-only side; adults can flip for spec and technical links.

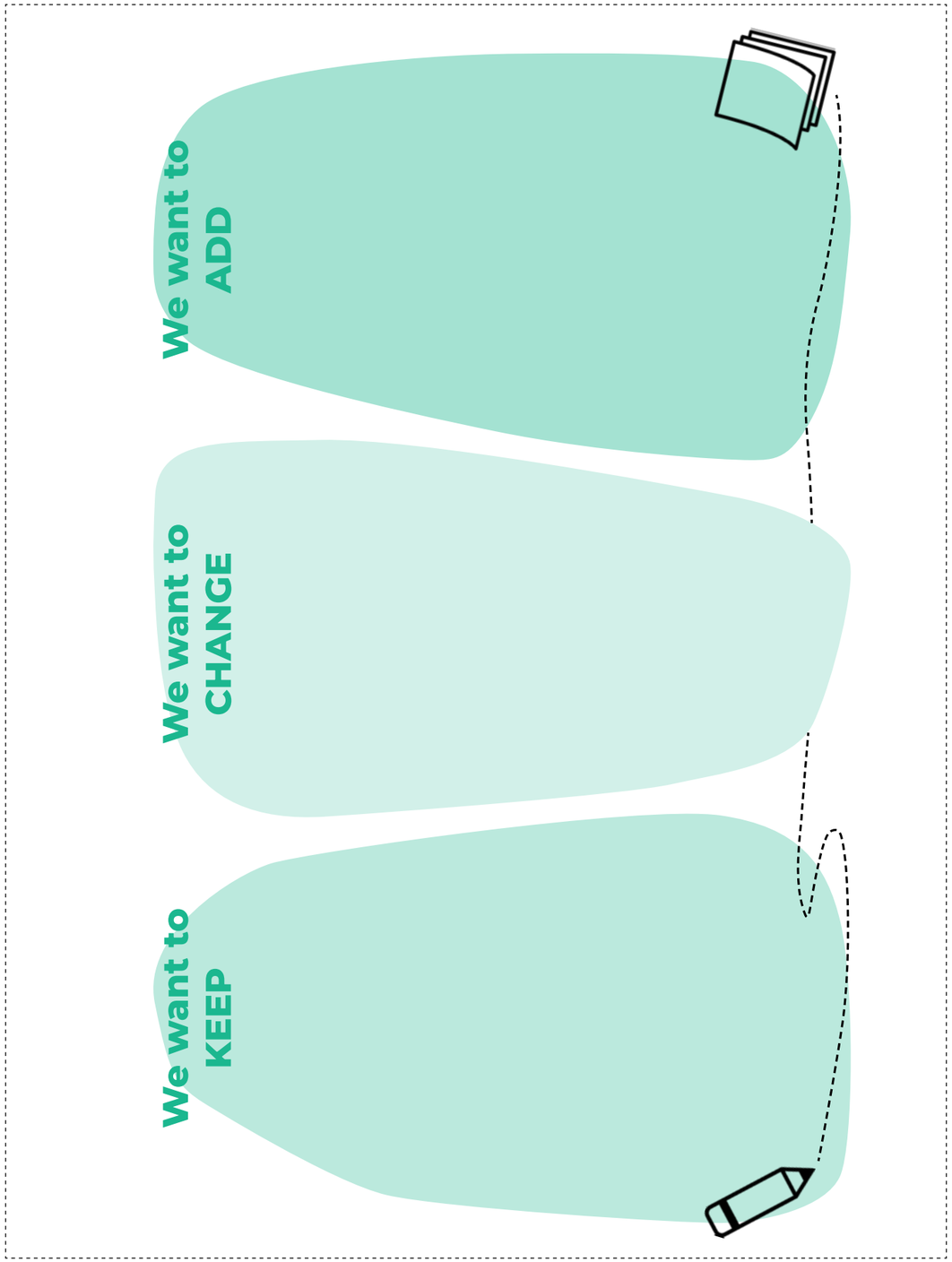
Note: *Risk driver set includes as well other environmental stressor cards such as: air, noise, and water pollution allowing for a more detailed and expnaded analysis of the schoolyard.*

Co-design materials





>>> Example of a A1/A0 base map with the satelite view and card holders.



>>> Example of a A2 poster for the prioritization exercise,

PHYSICAL IN-ACTIVITY

Spaces that don't encourage movement or play can lead to inactivity, reducing physical health, energy, and overall well-being.

HEALTH IMPLICATIONS

- Less movement → higher risk of obesity and cardiovascular diseases
- Low activity → reduced concentration and learning ability
- Sedentary time → higher stress, lower mood, and reduced emotional balance

OBSERVE YOUR SCHOOLYARD.

- Are there fun and safe places to move, run, or play?
- Do you feel encouraged to be active during breaks?
- What would make you move more in this space?

BIOTOPE LOSS

When natural elements like trees, grass, soil, and biodiversity are removed or missing, outdoor spaces lose their ability to support life, regulate climate, and offer healthy environments.

HEALTH IMPLICATIONS

- Lack of shade → overheating, less comfort outdoors
- Poor air quality → less filtering of pollution
- Lack of nature → reduced contact affects mental health, well-being, and learning

OBSERVE YOUR SCHOOLYARD.

- Are there enough plants, trees, or animals around?
- How does nature/or lack of, affect how you use the yard?
- What kind of plants or animals would you like to see here?

SPATIAL INEQUITY

When spaces are not designed for everyone, some people face more barriers. For example, unclear paths, poor access, or no places to feel safe and included.

HEALTH IMPLICATIONS

- Poor accessibility → harder to move, rest, or take part in social activities
- Unclear or chaotic spaces → sensory overload, stress
- Exclusion from spaces → feeling of isolation, reduced well-being

OBSERVE YOUR SCHOOLYARD.

- Can everyone move around the yard easily and safely?
- Are there calm, clear, or quiet areas to feel at ease?
- What would make the space more welcoming for all?

WATER POLLUTION

When harmful substances from streets, buildings, or waste enter drains, soil, or rivers, they pollute water and harm both the environment and health. During heavy rain, runoff spreads these pollutants faster.

HEALTH IMPLICATIONS

- Contaminated water → risk of illness, skin irritation, and allergies
- Polluted runoff → damages plants, soil, and local ecosystems
- Dirty surroundings → reduces comfort, outdoor use, and connection with nature

OBSERVE YOUR SCHOOLYARD.

- Where could dirty water or waste flow when it rains?
- Are there signs of pollution near drains or puddles?
- How might cleaner water and soil improve this place?

This page is intentionally left blank.

NOISE POLLUTION

Noise pollution is unwanted or constant sound from traffic, construction, or crowds. Long exposure raises stress levels, reduces focus and learning, and can even affect sleep and heart health.

HEALTH IMPLICATIONS

- Loud environments → stress, fatigue, and irritability
- Continuous noise → reduced focus and memory
- Chronic exposure → impacts sleep quality and heart health

OBSERVE YOUR SCHOOLYARD.

- Where do you hear the most noise during the day?
- How does noise change your ability to focus or relax?
- Are there places that feel calmer or quieter than others?

AIR POLLUTION

Air pollution comes from traffic, heating, and nearby industries. Polluted air contains particles and gases that affect breathing and overall health, especially during outdoor activities.

HEALTH IMPLICATIONS

- Polluted air → coughing, asthma, and breathing difficulties; headaches and lower energy
- Long exposure → impacts heart, lungs, and learning ability

OBSERVE YOUR SCHOOLYARD.

- What could cause air pollution near your school?
- When does the air feel less fresh or harder to breathe?
- Does air quality change how you use outdoor spaces?

EXTREME TEMPERATURES

Hot weather increases discomfort in spaces with lots of concrete, metal, or no shade and vegetation, making outdoor spaces uncomfortable and unsafe for health and play.

HEALTH IMPLICATIONS

- Heat stress → headache, fatigue, difficulty concentrating
- High temperatures → cardiovascular strain and breathing difficulties
- Less time outdoors → reduced play and physical activity

OBSERVE YOUR SCHOOLYARD.

- Where do you feel hottest during the day?
- Are there shaded places to rest?
- What's missing in the yard when it's hot?

EXTREME PRECIPITATIONS

Heavy rain can quickly lead to puddles and flooding, especially in yards covered with asphalt or other hard, impermeable surfaces, increasing injury and allergy risks.

HEALTH IMPLICATIONS

- Slippery surfaces → risk of falls/ injuries
- Standing water → mold, mosquitoes, allergies
- Less time outdoors → less movement/ activity

OBSERVE YOUR SCHOOLYARD.

- Where does water collect after rain?
- How does it affect your play or movement?
- What could make it safer or more fun?

This page is intentionally left blank.

COMMUNITY.

- Needs flexible, accessible, and welcoming outdoor spaces.
- Enjoys green, biodiverse areas for rest, activity, and gathering.
- Represents everyone who shares the space — promoting inclusion, care, and belonging.

DESCRIBE YOUR USER.

- What are his/hers needs?
- Which factors limit/put at risk the use of outdoor space?
- What could make it safer or more fun?

STUDENT.

- Needs space to move, explore, and play freely.
- Enjoys learning through curiosity, creativity, and interaction.
- Feels best in safe, shaded, and green areas that support rest and social interactions.

TEACHER.

- Needs visible, comfortable, and safe spaces for supervision and teaching.
- Requires adaptable areas that support both group activities and focused moments.
- Benefits from green, shaded, and calm places to decompress and recharge.

SCHOOL STAFF.

- Needs safe, ergonomic routes and protected work areas.
- Requires visibility, good lighting, and weather protection.
- Appreciates green, comfortable spaces that support rest and well-being during work.

JANITOR.

- Needs safe, ergonomic routes and practical access to service areas.
- Requires protection from weather, good storage, and clear organization.
- Benefits from green, well-maintained spaces that support comfort and pride in work.

MOTHER WITH CHILDREN.

- Needs step-free, visible, and comfortable areas to supervise and play together.
- Values safe paths, shaded seating, and access to essential facilities.
- Feels best in inclusive, green spaces that support care, rest, and interaction.

GRANPARENTS/ELDERLY CAREGIVERS.

- Need accessible paths, seating, and shaded resting spots.
- Value calm, safe areas where they can observe and connect with others.
- Benefit from barrier-free, green environments that support mobility and comfort.

This page is intentionally left blank.

REACTIVE
Design Principles

This section presents a set of cross-cutting design principles and guidelines to support transforming schoolyards and micro-urban school-related environments into climate-resilient, inclusive, and health-promoting places.

1. Health and Well-being First

Design decisions should prioritize physical and mental health, drawing on evidence-based health determinants such as movement, nature contact, thermal comfort, and social interaction (Halfon et al., 2014; WHO, 2022).

2. Child-Centered & Developmentally Supportive

Base spatial configurations on how children of different ages learn, play, and grow. This means offering varied environments for exploration, challenge, rest, and autonomy – and acknowledging the central role of schoolyards in daily life and development Erikson, 1950–1982; Piaget, 1952; Bronfenbrenner, 1979; Ginsburg, 2007).

3. Design for All Ages, Abilities, & Genders

Ensure that schoolyards are inclusive, safe, and welcoming for all children, regardless of age, gender, or ability. This includes physical accessibility, cognitive and sensory inclusion, and spaces for a range of developmental needs (UNICEF, 2021; WHO, 2007).

4. Climatic & Environmental Responsiveness

Orient and design spaces to respond to local climate conditions – including heat, rainfall, wind, and sun – and use materials and forms that reduce environmental burdens while enhancing comfort (IPCC, 2023; WHO, 2022).

5. Systems Thinking Across Scales

Schoolyards are not islands – they connect to streets, neighborhoods, and ecosystems. Every intervention should consider its systemic implications, including mobility, biodiversity, runoff, and access to public infrastructure (Doyle et al., 2022; UN-Habitat, 2020).

6. Nature Regeneration

Aim not only to minimize harm but also to regenerate urban ecosystems actively. This includes improving soil health, supporting pollinators, increasing canopy cover, and enhancing local biodiversity (UNEP, 2022; Kabisch et al., 2017).

7. Multifunctionality

Spaces should be designed to perform multiple roles simultaneously: a bioswale can be a play feature; a shaded bench can become a learning corner. Designing for multifunctionality optimizes limited space and fosters resilience (Woolley & Lowe, 2013; Basurto et al., 2021).

8. Diversity over Monofunctionality

9. Co-Ownership & Stewardship

Encourage involvement from the school community – children, teachers, families, and neighbors – in both design and care. This fosters a stronger relationship between people and place, ensuring long-term sustainability (Louv, 2008; Adams & Ingham, 2021).

REACTIVE
Design Guidelines

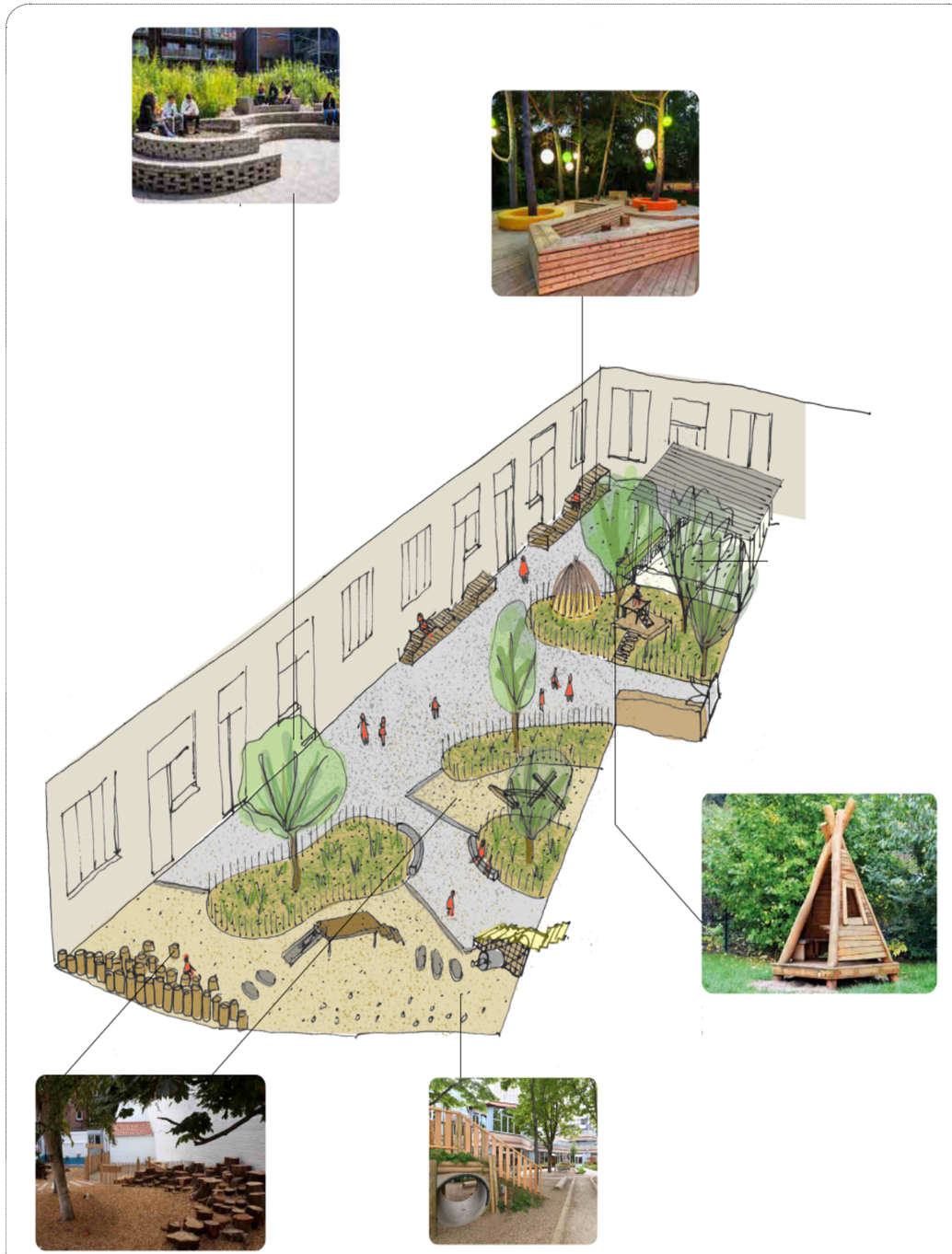
The REACTIVE design guidelines are the result of a screening and consolidation of ~30 strategies, derived from the in-depth analysis of each REACTIVE lens: climate resilience, biotope loss, physical activity, spatial inequity, and child development. The identified strategies were refined to prioritise actions that address multiple challenges simultaneously and deliver the highest co-benefits at the level of spatial design and systemic impact. The full cross-lens strategy matrix is reported in Part II (see p. XX).

The toolkit presents 10 guidelines that can be applied across macro, meso, and micro scales, plus one key micro-scale guideline specific to schoolyards. This micro-scale guideline is introduced first, as the zoning is the spatial organiser that makes all other strategies operational: it resolves conflicts (e.g., quiet vs active, shade vs sport, habitat vs circulation), sets performance expectations per zone, and provides the structure through which the following guidelines add quality, ensure integration, and manage risks and trade-offs coherently across the whole design.

Each guidelines is structured in factsheet as follows:

- **Purpose & impact (multi-lens)**
- **Strategies and actions**
- **Cross benefits**
- **Indicators (link to audits)**
- **Application across scales**
- **Tradeoffs**
- **Key solutions**

1. ***Zoning by Intensity & Age Needs (Micro-scale/Schoolyard)***
2. ***Shade & Radiant Control***
3. ***Cool-Permeable Ground Strategy***
4. ***Water-Sensitive Design***
5. ***Ecological Layering & Microhabitats***
6. ***Green Connectivity***
7. ***Movement Networks & Loops***
8. ***Affordance Landscape & Outdoor Learning***
9. ***Comfort Nodes & Restorative Micro-Spaces***
10. ***Universal Access***
11. ***Topography***



>>> *Zoning example, Opération Ré-création, Bruxelles, Belgium.*

#1 Zoning [micro/schoolyard scale]

AIM Key challenge when designing schoolyard is conflicting demands placed in the same space: quiet vs. ball games, habitat vs. desire lines, shade vs. sport programming, rain infiltration vs. accessible continuity. Zoning is the organiser that prevents these collisions and makes performance-based design legible and maintainable.

Organizing the yard into quiet / semi-active / active zones plus age-scaled subzones, designed as gradients (not hard separations) helps prevents conflicts (quiet vs active, shade vs sport, habitat vs circulation) and creates diverse and rich environmnte for different needs and uses.

DESIGN OBJECTIVES

+ **Conflict control:** separate uses through distance, buffering, and transitions (not signage).
+ **Age-fit + inclusion:** provide age-appropriate challenge and safe access without excluding slower/younger users.
+ **Comfort + climate:** place shade, wind refuge, and cool surfaces where pepple actually stay (waiting, rest, learning).
+ **Ecology protection:** locate habitat/soil zones away from trampling and define “no-compaction” edges.

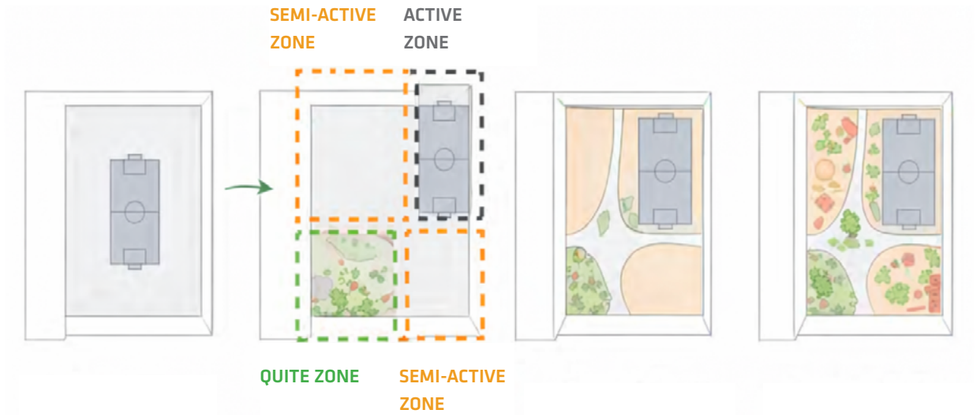
CROSS-CUTTING CONSIDERATIONS

	Zoning enables shade and cool materials where stationary use is highest (quiet + learning + waiting).
	Protects dry routes and keeps stormwater/habitat zones out of main desire lines.
	Concentrates habitat in protected zones with controlled access; reduces trampling and soil failure.
	Supports continuous movement loops plus targeted high-intensity zones.
	Avoids “best comfort for some only”; distributes rest, shade, and access across zones.
	Supports autonomy (wayfinding), risk calibration (age-fit challenge), and regulation (quiet recovery).

CORE INDICATORS

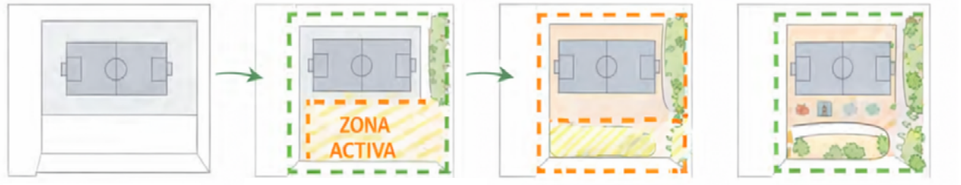
- ☐ **Zoning clarity:** quiet/semi/active zones legible on plan and on site (Y/N).
- ☐ **Conflict points:** observed collisions (ball spill, running through calm areas) + locations.
- ☐ **Age-fit provision:** presence of age-scaled areas + adjacency to supervision and amenities.
- ☐ **Dry/accessible continuity:** accessible loop/spine uninterrupted (including after rain).
- ☐ **Habitat protection:** no-compaction buffers and clear edges present (Y/N).

LARGE SCHOOLYARD



1. Starting point *2. Zoning* *3. Defining materials & forms* *4. Adding vegetation and affordances*

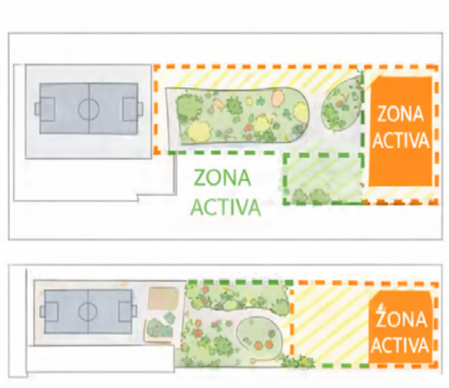
SMALL SCHOOLYARD



1. Starting point *2. Zoning* *3. Defining materials & forms* *4. Adding vegetation and affordances*

MEDIUM SCHOOLYARD

NARROW SCHOOLYARDS



>>> Zoning example for large and small schoolyard. MICOS project. (Adapted by the author with the use of Chat GPT).

#1 Zoning [micro/schoolyard scale]

SEMI-ACTIVE ZONE – Buffer + mixed-use
Typical use: loose parts, exploratory play, gardening, outdoor making, moderate movement.

Performance requirements
- Microclimate: mixed sun/shade; wind-moderated; comfort supports longer stays.
- Biotope: plantings selected and detailed to tolerate interaction (trampling edges, clear boundaries).
- Learning: incorporate work surfaces, storage, and legible processes (growth, water cycles, materials).

Spatial components
Open field/court + defined perimeter edge (seating / shade / water point) + clear circulation connection.

ACTIVE ZONE – High energy / high wear
Typical use: running, ball games, high-intensity social play, fitness.

Performance requirements
- Microclimate: provide edge shade and recovery proximity
- Water: no ponding on sport surfaces, ramps, or run-outs; controlled overflow must bypass desire lines.
- Durability: wear-tolerant surfaces and edges; robust drainage detailing; clear maintenance access.
- Equity: accessible viewing, participation routes, and inclusive entry points (not “spectator only”)

Spatial components
Open field/court + defined perimeter edge (seating / shade / water point) + clear circulation connection.

CALM ZONE – Restoration + focus
Typical use: decompression, small-group talk, quiet play, reading, observation, sensory regulation.

Performance requirements
- Microclimate: reliable shade; low radiant load; comfortable seating; avoid reflective/hot façade edges.
- Acoustic: buffered from active zones and streets; visual refuge without isolation.
- Equity: accessible seating options, micro-refuges, neurodiversity-friendly layout (choice, control, low conflict).
- Biotope: sensory planting and microhabitat edges where interaction is safe and maintainable.

Spatial components
Shaded seating clusters + small shelter/pergola + sensory planting + observation niche + direct access from loop.

#1 Zoning [micro/schoolyard scale]

METHODLOGY
Zoning works only if it follows microclimate and runoff logic

COMFORT BEFORE ZONING

1 *Performance scan*

REACTIVE MICRO Audit and/or map the drivers that determine where each activity can function.

- Sun / shade (midday + afternoon; seasonal if possible)
- Radiant edges (hot façades, reflected radiation, paved aprons near walls)
- Wind exposure / wind refuge (funnels vs sheltered pockets)
- Wetness / runoff (source > path > low points; muddy edges; ponding)
- Noise (street, courts, service areas)
- Circulation lines (gate-to-door, loops, short-cuts, waiting queues)

OUTPUT: base layer with 5 overlays (heat, shade, wind, wetness, noise) and circulation lines

ZONING

Design the yard as a continuous sequence rather than separated pockets:
Calm core / edge > Semi-active buffer > Active perimeter or field edge

2 *Age overlay*

Inside each intensity band, introduce age-scaled subzones (dimensions, equipment difficulty, risk level, seating heights, visibility). Keep permeability between ages where appropriate, but avoid forcing all ages into the same surfaces and conflict zones.

3 *Circulation loop*

Define a firm, barrier-free circulation loop that connects: gate →threshold →key destinations →calm/semi-active/ active zones →exits

4 *Assign zone*

Apply performance requirements per zone.

Stay zones (calm, learning, waiting, recovery) require comfort first (shade, low radiant load, dry footing, acoustic buffering).
Move zones (loops, sport, chase play) can tolerate higher exposure if recovery and shade are close and the surface remains safe.

TRADEOFFS

+ **Mixing vs conflict:** allow overlap only in semi-active edge zones; keep quiet cores protected.
+ **Access vs habitat:** keep habitat adjacent and visible, not inside primary routes.
+ **Sport vs shade:** shade spectators/edges; keep high-intensity cores clear where needed.

#1 Zoning [micro/schoolyard scale]

Age Group	Activity Zone	Typical Activities	Spatial/Design Features	Environmental Strategies
Nursery (0–3)	Calm	***Crawling, looking, and small group play***	Enclosed, soft flooring, sensory objects	Full shade, low vegetation, tactile materials
	Semi-active	***Sand, water play, mini gardens***	Raised beds, sensory paths	Partial shade, water features, safe surfaces
	Active	***Tricycles, low climbing, chase play***	Circular paths, small slides	Wind buffering, shaded circuits
Kindergarten/ Preschool (3-6)	Calm	***Reading corner, nature exploration***	Logs, cushions, bug hotels	Tree canopy, windbreak shrubs
	Semi-active	***Gardening, building, swinging***	Loose parts, digging areas	Deciduous trees, pergolas
	Active	***Running, climbing, imaginative play***	Obstacle course, soft mounds	Natural cooling, ventilation corridors
Elementary school (6-10/11)	Calm	***Drawing, storytelling, reflection***	Wooden decks, quiet shelters	Scent gardens, shaded seating
	Semi-active	***Art, nature lab, construction***	Outdoor tables, water elements	Mixed materials, filtered shade
	Active	***Sports, climbing, tag games***	Courts, balance logs, ramps	Shade sails, wind orientation planning
Middle school (10/11-14)	Calm	***Peer talk, rest, solo time***	Hammocks, benches, Wi-Fi points	Low-noise zones, green walls
	Semi-active	***Gardening, theatre, clubs***	Amphitheater, raised planters	Orientation to winter sun, summer shade
	Active	***Sports, skating, parcours***	Multi-use sport zone, open ground	Smart drainage, night cooling potential
High school (14-18)	Calm	***Quiet study, mindfulness***	Outdoor classrooms, beanbags	Solar panels for shade, cooling trees
	Semi-active	***Group discussion, music***	Creative walls, outdoor labs	Wind screens, water misters
	Active	***Basketball, fitness, games***	Gym zone, free play courts	Permeable surfaces, ventilation axes

Example Age intensity zoning matrix. The matrix translates the active / semi-active / calm zoning concept into age-responsive use patterns and the corresponding spatial and environmental performance requirements.

>>> *Tree canopy and pergola shade. Barcelona Climate Shelters*

#2 Shade & Radiation Control

AIM Keep school routes, entrances, and schoolyards usable during heat by reducing solar exposure and radiant load, while keeping spaces daylit and safe

DESIGN OBJECTIVES

+ **Shade continuity:** ensure continuous shade on the primary movement spine (route–gate–door–yard) and all accessible routes.
+ **Radiant load reduction**: lower mean radiant temperature in waiting, queueing, and recovery zones (shade + surface strategy).
+ **Heat-safe use:** prevent overheated ground and seating in high-contact child zones (play, waiting, ramps).
+ **Robustness:** systems remain functional under wind, drought, seasonal leaf loss, and routine school use (wear, vandalism).

CROSS-CUTTING CONSIDERATIONS

	Reduces heat stress by lowering radiant load and improving thermal comfort in stationary zones.
	Canopy and shade structures can support dry waiting/arrival when integrated with drainage (no dripping lines onto queues).
	Tree canopy and planted shade zones strengthen habitat and soil function when rooting volumes are protected.
	Extends safe outdoor use and reduces heat-related avoidance of routes/play.
	Improves equity by ensuring shaded access and waiting for all users (younger children, strollers, wheelchairs).
	Supports outdoor learning, sensory comfort, and self-regulation by providing shaded micro-refuges and legible comfort zones.

CORE INDICATORS

- ☐ **Shade continuity (route–gate–door–yard + accessible routes):** % of gate–door–yard spine shaded (including ramps/landings) + Shade coverage: % shade over critical paths at peak hours (summer).
- ☐ **Exposure hotspots:** count/location of unshaded queue/wait/play cores .
- ☐ **Surface overheating:** presence of heat-risk materials in high-contact zones (ground, seating, ramps).
- ☐ **Glare risk:** reflective surfaces facing learning/rest zones or key sightlines; Envelope solar control: presence/quality of external shading on sun-exposed façades and glazing at entrances/classrooms (Y/N).

#2 Shade & Radiation Control

METHODOLOGY

1 Solar + Exposure Mapping (Radiation logic)

Define sun and radiation as design drivers before choosing solutions.

- Build a quick exposure index: sun hours + orientation + lack of canopy + hardscape share (verify with summer site walk if possible).
- Map hotspots: waiting zones, crossings/stops, gate queues, play cores, "last 200 m" route segments.
- Mark critical use lines: gate-to-door, accessible paths, main play loop, recovery nodes.

2 Shade Hierarchy (Where shade is non-negotiable)

Prioritize: waiting/queueing + crossings/stops + accessible ramps/landings + main circulation.

- Set a shade target by use: full shade for waiting/recovery; partial shade for circulation; mixed for play.
- Place shade to cover bodies, not just ground: align with desire lines and stationary zones.

3 Layered Shade System (Trees + built shade)

Design Use trees as primary long-term canopy where soil volume and irrigation can support survival.

- Add built shade where trees cannot deliver performance (tight thresholds, hard forecourts, immediate "need now" areas).
- Combine layers: canopy + lightweight canopies/pergolas for predictable coverage and seasonal resilience.

4 Radiant + Surface Control (Ground, edges, façades)

Reduce radiant heat gain where people touch, sit, and wait.

- Avoid high-heat surfaces in sun-exposed zones; prioritize cooler pavements under shade and at recovery nodes.
- Control glare: balance reflectance with shade/texture; avoid highly reflective finishes at eye level.
- Use edge shading: shaded seating, shaded walls/edges, and cool micro-spaces near active areas.

5 Hybrid Shade Spaces (Comfort + use, by design)

Use shade to create usable "climate rooms" for learning, waiting, and recovery.

- Make shade legible: shaded thresholds, shaded outdoor classrooms, shaded queue lines.
- Combine function: shaded seating + drinking water + calm pocket space within short reach of play/arrival.
- Protect performance: prevent soil compaction under trees (root-zone protection, edging, maintenance access).

SCALE APPLICATION EXAMPLES

MACRO SCALE *Routes, crossings, public realm near schools*	Prioritize high-exposure segments; retrofit crossings/stops for shaded waiting; add tree lines or continuous shade bands on the "last 200 m"; ensure shade does not block visibility at crossings.
MESO SCALE *Thresholds, forecourts, edges of premises*	Guarantee shaded, thermally safe arrival and indoor–outdoor comfort: cover gate queues and ramps/landings; provide shaded waiting edges + water; reduce façade and glazing solar gains with external shading (louvers/overhangs), treated window ratios, and shaded buffer zones (porches/arcades). Coordinate shade with drainage so runoff does not discharge onto queues.
MICRO SCALE *Schoolyard*	Create a shaded network: shade over play cores + recovery nodes; ensure a shaded accessible spine; distribute shade so comfort is not limited to one "premium corner."

#2 Shade & Radiation Control

TRADEOFFS

+ **Shade vs daylight**: shade stationary zones first; keep learning areas daylit with filtered canopy/pergola patterns.
+ **Trees vs maintenance/water:** specify soil volume + irrigation logic + protection from compaction; choose robust species.
+ **Shade structures vs wind/vandalism:** use durable, repairable systems with clear fixing logic and safe clearances.

SOLUTIONS

+ **Tree canopy system:** large-canopy deciduous trees (where climate fits) + protected rooting volume + irrigation establishment.
+ **Lightweight tensile canopy**: over queues/waiting/thresholds; UV-rated membrane; designed dripline away from desire lines.
+ **Rigid canopy / arcade:** continuous covered spine at entrances and primary outdoor circulation (steel/timber/aluminium).
+ **Pergola with climbers:** seasonal shade + evapotranspiration; integrated trellis + maintenance access.
+ **External solar-control devices:** fixed overhangs, vertical fins, operable louvers for façades/ glazing (esp. west/south exposures).
+ **Shaded thresholds:** porch/deep reveal/vestibule extension that couples indoor comfort + outdoor arrival space.
+ **Shade-integrated seating + recovery node:** shaded bench/table + drinking water point + calm pocket (micro-refuge).
+ **Cool–shaded ground pairing at hotspots:** shade element + heat-safe surface in the same spot (waiting/play/learning edges).

REFERENCES & EXAMPLES

REFERENCES

+ World Health Organization. (2021). WHO guidance on heat and health. World Health Organization.
+ World Health Organization Regional Office for Europe. (2016). Urban green spaces and health: A review of evidence. WHO Regional Office for Europe.
+ IPCC. (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability (AR6 WGII). Cambridge University Press.
+ Dessì, V. (2007). Progettare il comfort urbano. Soluzione per un'integrazione tra società e territorio

RELEVANT EXAMPLES

+ Barcelona "Climate Shelters" in schools (shade + cooling + play upgrades).
+ Paris "Cours Oasis" schoolyard transformations (heat + water + greening).
+ Brussels "Opération Ré-création" (regional program for greener, cooler schoolyards).

>>> *Mineral roof garden, Banco Safra headquarters, São Paulo, 1983. Photograph © Leonardo Finotti*

#3 Ground strategy

AIM Reduce surface heat load and manage rainfall where it lands, while keeping primary routes firm, slip-safe, and barrier-free.

DESIGN OBJECTIVES

+ **Thermal risk reduction:** lower peak surface temperatures and radiant exposure in high-use zones (routes, play cores, queues).
+ **Runoff + ponding control:** reduce ponding frequency/depth through infiltration + sub-base storage + safe overflow routing.
+ **Accessible continuity:** guarantee firm, slip-safe, barrier-free routes under wet/dry conditions (gate–door–yard).
+ **Robustness:** surfaces and sub-bases resist clogging, settlement, and school-use wear (sediment + compaction + maintenance).

CROSS-CUTTING CONSIDERATIONS

	Reduces heat stress by limiting surface overheating and hot-contact zones on routes, queues, and play edges.
	Reduces ponding and slippery wet surfaces through infiltration/storage and controlled overflow that keeps desire lines dry.
	Supports living soil and planting durability when permeable/retentive ground is paired with protected soil volumes and planted edges (not thin “dead strips”).
	Extends safe outdoor use and walking/play by preventing heat-avoidance, mud traps, puddles, and slippery breakdown points.
	Improves equity by ensuring firm, slip-safe, barrier-free continuity for all users (strollers, wheelchairs, slower walkers) in wet and dry conditions.
	Supports sensory exploration and skill-building through texture gradients placed adjacent to an accessible smooth lane (tactile richness without barriers).

CORE INDICATORS

- ☐ **Surface overheating**: hottest-zone identification in high-contact areas (spot checks / simple IR where available).
- ☐ **Ponding**: presence/absence + typical depth after rain at mapped low points (photo log).
- ☐ **Critical route continuity:** % of primary route passable after rain (including ramps/landings).
- ☐ **Permeable/retentive placement:** permeable/vegetated areas located on flow paths (yes/no + where).
- ☐ **Slip/failure points:** observed slick zones + edge/joint damage, settlement, scouring, clogging.

#3 Ground strategy

METHODOLOGY

① Ground Risk Mapping (Heat + Water + Use)

Define ground performance before choosing materials.

- Map: solar exposure + hottest surfaces + shade gaps; and water logic: source > path > low points > overflow.
- Mark critical use lines: gate-to-door, accessible paths, waiting zones, play loop, quiet/recovery spots.
- Identify "conflict zones": high-contact + high heat + ponding risk (ramps, thresholds, queue aprons, play edges).

② Thermal–Hydrologic Specification (Performance by zone)

Specify surfaces by three properties: thermal, hydrologic, usability.

- Thermal: limit heat storage and extreme surface temps (avoid black defaults; manage glare).
- Hydrologic: infiltration/detention where feasible; sub-base storage where soils are poor.
- Usability: slip resistance, firmness, and cleanability for child-scale contact and mobility aids.

③ Surface Palette by Use (Thermal + slip + comfort)

Specify surfaces by use zone (not one material everywhere).

- Movement routes: firm, smooth, slip-resistant, drainable (no clog-prone finishes without maintenance access).
- Waiting/queue edges: cooler underfoot, slip-safe, comfortable for standing + stroller maneuvering.
- Play/sport: impact-safe where needed, but verified for heat (avoid large exposed black rubber fields as default).
- Sitting/rest: cooler touch surfaces, low glare, fast-drying edges.
- *Rule*: if a surface is likely to be touched/occupied by children, heat and slip performance are primary specs, not aesthetics.

④ Texture Gradient (Sensory without barriers)

Use texture as a designed gradient.

- Keep a continuous accessible "smooth lane" and place tactile zones adjacent: mulch/wood chips, gravel-in-cells, planted edges, stepping textures.
- Contain loose materials with clean edges and flush transitions; avoid loose textures on ramps, landings, and main desire lines.
- Use texture intentionally: sensory exploration, micro-play, orientation, and speed modulation.

SCALE APPLICATION EXAMPLES

MACRO SCALE *Routes, crossings, public realm near schools*	Prioritize high-exposure segments; retrofit crossings/stops for shaded waiting; add tree lines or continuous shade bands on the "last 200 m"; ensure shade does not block visibility at crossings.
MESO SCALE *Thresholds, forecourts, edges of premises*	Guarantee shaded, thermally safe arrival and indoor–outdoor comfort: cover gate queues and ramps/landings; provide shaded waiting edges + water; reduce façade and glazing solar gains with external shading (louvers/overhangs), treated window ratios, and shaded buffer zones (porches/arcades). Coordinate shade with drainage so runoff does not discharge onto queues.
MICRO SCALE *Schoolyard*	Create a shaded network: shade over play cores + recovery nodes; ensure a shaded accessible spine; distribute shade so comfort is not limited to one "premium corner."

#3 Ground strategy

TRADEOFFS

+ **Cool surfaces vs glare** > prefer mid-reflectance + texture; use shade as support, not as the only fix.
+ **Permeability vs accessibility** > firm-permeable for routes; loose/soft textures adjacent with containment.
+ **Impact surfacing vs heat** > verify heat performance; avoid exposed dark rubber dominance.
+ **Permeability vs maintenance** > include sediment control and access points; avoid clog-prone details without cleaning logic.

SOLUTIONS

+ Use-zoned surface palette (route / queue / play / rest) with heat + slip performance requirements
+ Engineered permeable paving with storage sub-base + inspection access (where appropriate)
+ Permeable threshold apron + infiltration band at gates/forecourts (no ponding rule)
+ Rain garden / detention planter at mapped low points with controlled overflow
+ Texture gradient kit: smooth accessible lane + contained tactile zones (mulch, gravel-in-cells, planted edges)
+ Sediment control details: protected inlets, silt traps, maintainable joints/slots

REFERENCES & EXAMPLES

REFERENCES

+ Dessì, V. (2007). Superfici: Materiali e tecniche per l'architettura del suolo. Sistemi Editoriali.
+ U.S. Environmental Protection Agency. (2014/2017). Reducing Urban Heat Islands: Compendium of Strategies – Cool Pavements. EPA.
+ European Committee for Standardization. (2018). EN 1177: Impact attenuating playground surfacing – Determination of critical fall height. CEN.

RELEVANT EXAMPLES

+ Boston Schoolyard Initiative (Boston): long-running retrofit programme; practical standards/ specs frequently address surfacing and durability.
+ Paris "Cours Oasis": strong operational guidance on surfaces, permeability, and maintenance logic across school sites.
+ Space to Grow (Chicago): depaving + permeable/green stormwater landscapes in schoolyards (also impacts surface heat).

>>> Designing with water.

>>> Hybrid example: Water square Tiel, NL (DE URBANISTEN)

#4 Water Sensitive Design

AIM Keep routes, entrances, and schoolyards usable during/after rain, while turning stormwater into a visible, ecological, and educational asset (not a hazard).

DESIGN OBJECTIVES

+ **Dry-feet continuity**: ensure non-flooded, slip-safe access along the primary movement spine (gate–door–yard) and all accessible routes.
+ **Runoff peak reduction:** reduce ponding frequency and depth at low points through infiltration + detention + controlled overflow.
+ **Water quality + hygiene**: prevent exposure to contaminated runoff in high-contact child zones (waiting, play, ramps).
+ **Robustness:** systems remain functional under intense downpours, sediment loads, and routine school use (compaction).

CROSS-CUTTING CONSIDERATIONS

	Blue–green systems can reduce surface temperatures through evapotranspiration when soil moisture and planting health are maintained.
	Attenuates peak runoff and reduces ponding at thresholds/low points via infiltration + detention + controlled overflow.
	Supports living soil function and planting durability when soil volumes are protected (anti-compaction + adequate rooting).
	Maintains all-weather usability (dry-foot routes and playable surfaces), reducing rain-related “avoidance” of walking and outdoor time.
	Improves equitable access by keeping key routes and waiting areas usable for all users under wet conditions (strollers, wheelchairs, slower walkers).
	Supports outdoor learning and legible water processes only in controlled, hygienic zones (visible flow lines, clear boundaries, shallow “safe water” design).

CORE INDICATORS

- ☐ **Ponding:** presence/absence + typical depth after rain at mapped low points (qualitative + photo log).
- ☐ **Permeability ratio:** % permeable/vegetated surfaces in the audited area; location relative to flow paths.
- ☐ **Critical path continuity:** % of critical route that remains passable after rain (including ramps).
- ☐ **Drainage function:** number/condition of inlets, sediment traps, and inspection points (working/not).
- ☐ **Roof management:** roof discharge type (direct to sewer / disconnected / stored/ harvested).
- ☐ **Water quality exposure risk**: presence of runoff inflows from traffic/parking or “dirty” surfaces entering high-contact child zones (waiting/play/ramps) (Y/N + mapped points), and whether pre-treatment/separation is provided (Y/N).

#4 Water Sensitive Design

METHODOLOGY

1 *Stormwater Flow Mapping (Runoff logic)*

Define runoff as a design driver before choosing solutions.

- Build a quick runoff index: contributing area + surface type + slope + known ponding points (site walk after rain if possible).
- Map source > path > low points > outfall/overflow (include roofs and adjacent streets).
- Mark critical use lines: gate-to-door, accessible paths, main play loop, waiting zones.

2 *Slow–Store–Soak (Distributed blue–green system)*

- Slow: break flow with roughness + vegetation + check points (swales, planted strips, micro-berms).
- Store: provide temporary storage in safe places (rain gardens, detention planters, sub-base storage).
- Soak: maximize infiltration where soil allows (infiltration trenches, tree pits with soil volume, permeable sub-bases).

3 *Dry-Feet Continuity (Access and usability)*

Guarantee dry, barrier-free continuity in everyday routes.

- Design a primary dry spine (gate > threshold > key zones) with slip-safe detailing and positive drainage.
- Place infiltration/retention beside desire lines, not inside them; keep accessible routes firm and continuous.
- Where exposure is unavoidable, use covered segments selectively (thresholds, queues, waiting).

4 *Safety Detailing (Slip, slope, ponding control)*

Prevent "failure moments" at child scale: slips, pooling, blocked ramps.

- No ponding at gates, doors, ramps, crossings, stop waiting areas: micro-falls, edge drains, permeable transitions.
- Specify slip resistance and drainage detailing for all high-use wet surfaces (no "pretty but slick" finishes).
- Design controlled overflow (spillways) that bypasses child desire lines and does not erode edges.

5 *Hybrid Water Spaces (Learning + ecology, by design)*

Use water visibly only where it is safe, shallow, and maintainable.

- Make stormwater legible: channels + visible inlets/outlets + planted retention that shows wet/dry cycles.
- Combine function: water square / floodable playcourt / rain-garden edge seating

SCALE APPLICATION EXAMPLES

MACRO SCALE *Routes, crossings, public realm near schools*	Prioritize flood-prone segments; retrofit crossings/stops for dry waiting (no puddle boarding); add infiltration bands/tree trenches where runoff accumulates; ensure overflow does not cut across pedestrian desire lines.
MESO SCALE *Thresholds, forecourts, edges of premises*	Guarantee dry-feet arrival: permeable + slip-safe threshold surfaces, infiltration strips/ tree pits at forecourts, roof runoff disconnection, and protected drainage details at ramps/ landings.
MICRO SCALE *Schoolyard*	Increase retention/infiltration capacity at low points, ensure a dry accessible spine across the yard, and integrate visible safe flow lines where educational value is desired; avoid concentrating mud/water in primary play cores.

#4 Water Sensitive Design

TRADEOFFS

+ **Infiltration vs accessibility:** maintain continuous firm routes; place loose/soft infiltration surfaces adjacent, with clear edge containment.
+ **Green-blue systems vs maintenance:** specify inspection points + sediment control; choose robust palettes and details that tolerate school use.
+ **Rain-play vs safety/hygiene:** only with shallow design + clean sources + controlled drainage; never in contaminated runoff zones.

SOLUTIONS

+ Permeable paving system with engineered sub-base + inspection access
+ Infiltration strip / permeable band along desire lines + thresholds
+ Rain garden / bioswale located at mapped low points (with overflow)
+ Tree trench / structural soil tree pits intercepting runoff + supporting shade
+ Shallow swales / runnels for safe, visible conveyance (optional)
+ Downspout disconnection to planters/tree pits or infiltration trench
+ Rainwater storage/harvesting for irrigation + delayed release
+ Sediment control package: silt traps + protected inlets + maintenance points

REFERENCES & EXAMPLES

REFERENCES

+ World Health Organization Regional Office for Europe. (2017). Urban green spaces: A brief for action. WHO Europe.
+ Arup. (2020). Compendium of adaptation and resilience measures for schools (Greater London Authority Climate Adaptation Plans for Schools). Arup.
+ City of Rotterdam. (2013). Rotterdam Climate Proof: Rotterdam adaptation strategy (climate adaptation framework). City of Rotterdam.

RELEVANT EXAMPLES

+ Water Square Benthemplein (Rotterdam): floodable public space storing runoff; clear precedent for "visible but controlled" water.
+ Climate Resilient School, London: SUDs application and water saving measures.
+ Evergreen Climate Ready School: sponge city principle applied to schoolyard grounds.

>>> SUDs planters for water collection and educational purposes. London Climate Resilient Schools.

>>> Ecological layering example

#5 Ecological Layering & Microhabitat

AIM A “green” school space can still be biologically poor if it is flat lawn and isolated trees. Layered vegetation and small habitats contribute to microclimate, support soil and water performance, and offer contact with nature.

DESIGN OBJECTIVES

+ **Biotope performance:** increase habitat quality through layered structure + species diversity
+ **Heat buffering:** strengthen canopy + understory cooling in waiting, circulation, and recovery zones.
+ **Robustness**: protect soils and planting from trampling, compaction, and edge failure.
+ Equitable access: distribute nature contact and comfort along everyday desire lines, not in a single “nice corner.”
+ **Child development:** provide legible, supervised nature interaction (observation, care, stewardship) without unsafe hiding spots.

CROSS-CUTTING CONSIDERATIONS

	Layered vegetation (canopy + understory) reduces radiant load and improves recovery comfort along routes and edges.
	Vegetation supports interception, infiltration, and erosion control when soils are protected and connected to flow paths.
	Increases habitat quality through vertical layering, continuity, and seasonal diversity (not only planted area).
	Contributes to cooler, more attractive routes and play edges.
	Distributes nature-contact and comfort along everyday desire lines, not only in one “premium corner.”
	Supports attention restoration, curiosity, and stewardship through legible, supervised nature interaction.

CORE INDICATORS

- ☐ **Canopy/understory shade distribution:** presence/coverage of layered shade along key circulation and recovery edges (qualitative + photo log).
- ☐ **Layering presence:** % of planted zones with 2–3 strata (ground + shrub + tree), not only lawn.
- ☐ **Continuity**: length of continuous ecological edge/corridor along routes and perimeters (m).
- ☐ **Microhabitat provision:** number + condition of habitat elements (working/not; visible/supervised).
- ☐ **Soil protection:** evidence of trampling/compaction at planting edges (Y/N + mapped locations).
- ☐ **Edge failure/erosion:** exposed soil, undermined paving, sediment movement at green–hard interfaces (Y/N).

#5 Ecological Layering & Microhabitats

METHODOLOGY

1 Habitat mapping and layering plan

Define ecology as a spatial layer before choosing plants.

- Map sun/wind exposure, wet/dry zones, disturbance intensity (queues, play edges, shortcuts), and "quiet edges." Assign where ground–shrub–tree strata can survive school use, and where biodiversity must be protected by clear boundaries.

2 Layered Edge and Corridor System

Build a continuous living edge that stabilizes microclimate and habitat.

- Prioritize perimeters, route edges, and forecourts for layered bands: canopy trees + understory shrubs + groundcover/meadow pockets.
- Avoid monocultures and single-species rows; design continuity to reduce fragmentation and improve ecological function.

3 Microhabitats

Add habitat features as controlled, repeatable elements.

- Use microhabitats only where they can be protected and maintained: pollinator strips, deadwood/stone pockets, nesting boxes, "no-mow" patches, small shaded refuges.

4 Building Interface Ecology

Use the building edge to add habitat and reduce heat stress.

- Where appropriate, integrate green façades, pergolas, and roof-based ecology (green/blue roof logic) with safe drainage and maintenance access. Keep daylight/ventilation logic intact and avoid creating damp, shaded "problem strips" at the base.

SCALE APPLICATION EXAMPLES

MACRO SCALE *Routes, crossings, public realm near schools*	Create corridor planting with layered structure along school approaches; connect street trees, verges, and infiltration bands into continuous habitat edges; avoid compacted "dead strips" by protecting soil volumes where planting is expected to perform.
MESO SCALE *Thresholds, forecourts, edges of premises*	Build layered perimeter planting that buffers heat and wind at entrances; place microhabitats in protected interaction zones (visible, supervised); integrate green façades/pergolas where they improve comfort and support habitat without compromising access, daylight, and maintenance.
MICRO SCALE *Schoolyard*	Use ground–shrub–tree strata as the default edge system; locate microhabitats in low-disturbance pockets (learning gardens, quiet edges); protect soils with clear boundaries so biodiverse zones remain durable under daily school use.

#5 Ecological Layering & Microhabitats

TRADEOFFS

+ **Habitat richness vs visibility/safety:** keep sightlines; avoid hidden pockets; locate dense habitat in supervised edges.
+ **Ecology vs maintenance:** standardize details; choose robust palettes; provide access points and simple upkeep logic.

SOLUTIONS

+ Layered edge planting band (groundcover + shrubs + canopy trees) with clear containment
+ Pollinator strip / seasonal meadow pocket in protected zones
+ Microhabitat kit: deadwood/stone pocket + nesting boxes (supervised placement)
+ Pergola / green façade system for shade + habitat at entrances and learning edges
+ Green/blue roof (where feasible) with safe drainage + maintenance access
+ Root-zone protection + adequate soil-volume tree pits / planters at high-pressure edges

REFERENCES & EXAMPLES

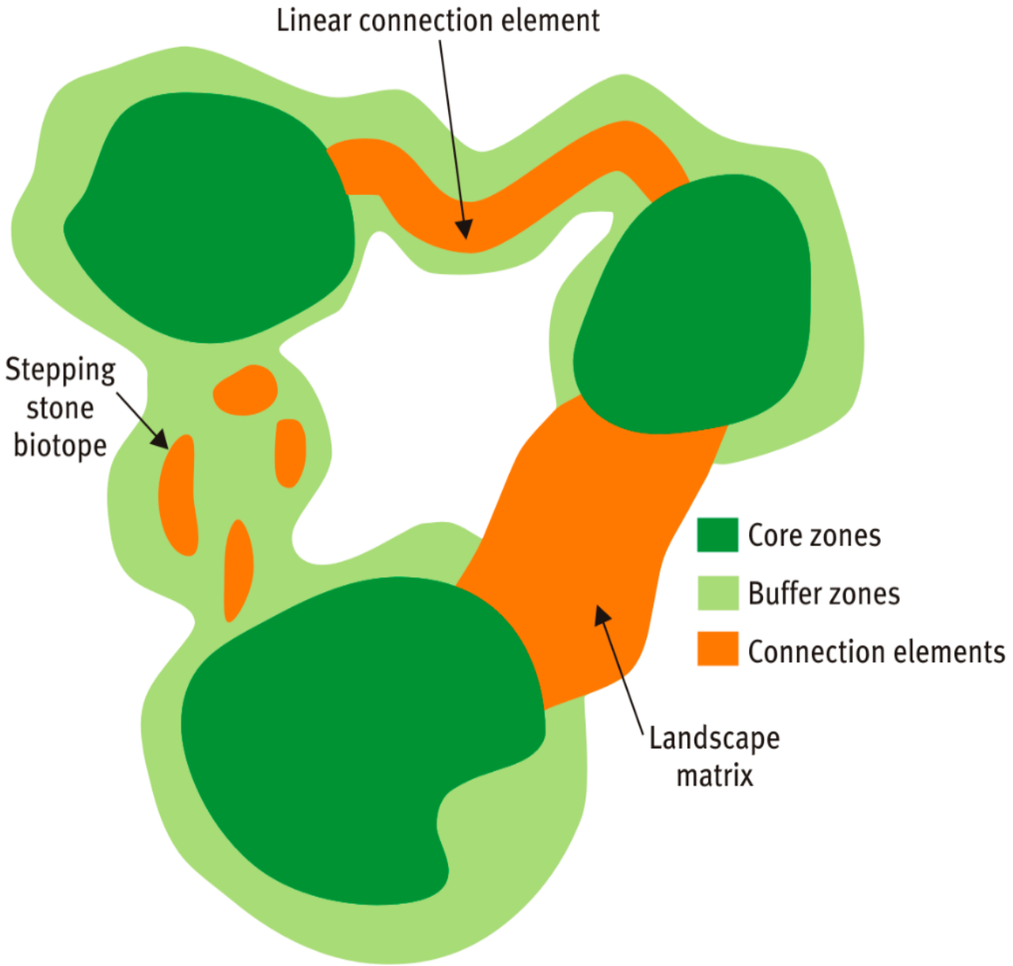
REFERENCES

+ World Health Organization Regional Office for Europe. (2017). Urban green spaces: A brief for action. WHO Europe.
+ IUCN. (2020). Global Standard for Nature-based Solutions: A user-friendly framework for the verification, design and scaling up of NbS. IUCN.
+ National Wildlife Federation. (n.d.). Schoolyard Habitats® / schoolyard habitat resources. NWF.

RELEVANT EXAMPLES

+ Opération Ré-création (Brussels): biodiversity + climate resilience via layered greening in schoolyards.
+ Toyota Evergreen Learning Grounds: multi-city programme emphasizing living systems + nature contact in school grounds.
+ Green Schoolyards America: guidance + built examples focusing on nature-based, durable, child-facing habitat.

>>> Ecological layering example. Greenschoolyards America.



>>> >>> Diagram of an ecological network with its different elements.

#6 Green Connectivity

AIM Design the school environment as a connected green–cool–habitat system across route–edge–yard (not isolated "nice planting"). The main strategy is to connect patches, remove breaks, and build continuity where children move and where ecology can persist.

DESIGN OBJECTIVES

+ **Continuity**: connect canopy, soil, and habitat across the school influence area (routes–edges–yard).
+ **Climate buffering**: reduce radiant load and heat exposure through connected shade + evapotranspiration.
+ **Stormwater synergy**: align green connectivity with runoff paths (soil volumes that intercept, infiltrate, and survive).
+ **Equity + daily use:** deliver benefits along real child desire lines (walking, stops, crossings, waiting, threshold).

CROSS-CUTTING CONSIDERATIONS

	Connected canopy and planted corridors reduce radiant exposure along routes and edges.
	Connected soil volumes intercept runoff, support infiltration, and reduce ponding at edges and low points.
	Improves habitat persistence by reducing fragmentation and increasing structural diversity and continuity.
	Contributes to cooler, more attractive routes and play edges.
	Distributes nature-contact and comfort along everyday desire lines, not only in one "premium corner."
	Supports nature-contact routines, orientation, and exploration when edges are safe, legible, and supervised.

CORE INDICATORS

- ☐ **Green breaks**: mapped locations/length of canopy or planted-edge gaps on priority routes.
- ☐ **Stepping stones:** number + spacing of connected nodes along desire lines (per 200 m).
- ☐ **Soil continuity:** % of edge/route with functional soil band (not compacted dead strip).
- ☐ **Canopy continuity:** qualitative continuity score along the last 200 m (photo log).
- ☐ **Runoff alignment:** % of connectivity elements positioned on/near flow paths or low points.
- ☐ **Vegetation performance:** dieback/compaction evidence at edges and waiting zones.

#6 Green Connectivity

METHODOLOGY

1 *Connector Hierarchy (Corridor + stepping stones)*

Define how continuity will be built before choosing elements.

- Use continuous corridors as the default (tree + understory + soil band).
- Where corridors cannot be continuous, design stepping-stone nodes (small connected patches that bridge gaps).

2 *Priority Nodes (Where connectivity must not break)*

Prioritize the places where children stop and exposure is highest..

- Focus on crossings, stops, corners, forecourts, and "last 200 m" segments.
- At these nodes, combine shade + soil volume + legible edges so the connector performs ecologically and works in everyday use.

3 *Soil Continuity & Protection*

Treat soil as the infrastructure of connectivity.

- Protect soil performance with clear boundaries: edging, planting guards, defined paths, and maintenance access.

4 *Edge Legibility & Safe Nature Contact*

Make green connectors usable and readable, not hiding places or conflict edges..

- Keep sightlines: place denser layers where supervision is possible and use lower/filtered planting near entrances and corners.
- Use edges to guide movement (benches/low borders/planting bands) without creating barriers on primary desire lines

5 *Maintenance*

- Plan for: seasonal care, litter removal, replacement strategy, and protection from compaction at high-pressure edges.

SCALE APPLICATION EXAMPLES

MACRO SCALE *Routes, crossings, public realm near schools*	Connect green patches across the school influence area: tree corridors where feasible, stepping-stone nodes at crossings/stops, and soil-based bands that align with runoff and exposure hotspots.
MESO SCALE *Thresholds, forecourts, edges of premises*	Turn the perimeter/forecourt into an active connector: planted edge bands with soil volume + protection, shaded waiting zones, and green continuity that ties street ecology to the school frontage.
MICRO SCALE *Schoolyard*	Build internal continuity and "plug-in" alignment: connect canopy–understory–ground layers across zones, orient habitats and water elements toward external links, and avoid isolated pockets that don't connect.

#6 Green Connectivity

TRADEOFFS

+ **Security vs permeability:** keep controlled access and sightlines while using planted buffers and soil-based edges.
+ **Connectivity vs maintenance:** prioritize robust palettes + protected soils; avoid thin strips with no rooting volume.
+ **Greening vs heat/water stress:** place planting where it receives water; provide irrigation logic where needed.

SOLUTIONS

+ Tree trench / structural soil corridor (continuous soil + canopy)
+ Stepping-stone nodes (corner beds, curb extensions, pocket planters with soil volume)
+ Planted perimeter edge band (hedgerow/climbers + protected rooting zone)
+ Shaded threshold/forecourt planting with soil volume (queue + comfort)
+ Infiltration planting bands aligned with flow paths (dual stormwater + ecology)
+ Habitat "connector kit" (pollinator strip, deadwood/stone edge microhabitats in protected zones)

REFERENCES & EXAMPLES

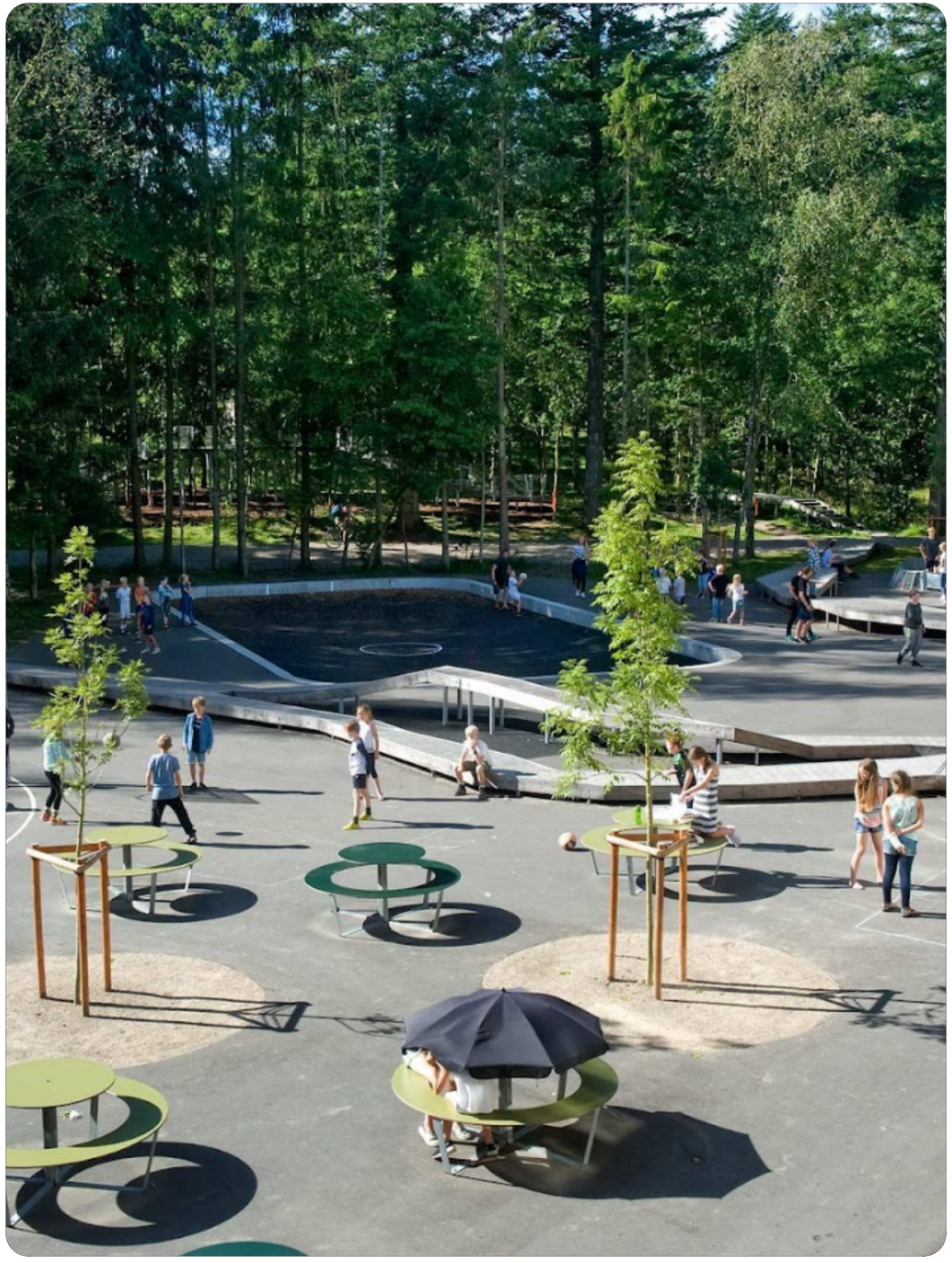
REFERENCES

+ European Commission. (2013). Green Infrastructure (GI) — Enhancing Europe's Natural Capital (COM/2013/0249 final). European Commission.
+ IUCN. (2020). Global Standard for Nature-based Solutions. IUCN.
+ World Health Organization Regional Office for Europe. (2017). Urban green spaces: A brief for action. WHO Europe.

RELEVANT EXAMPLES

+ Opération Ré-création (Brussels): biodiversity + climate resilience via layered greening in Barcelona Climate Shelters: connects route/yard interventions into a broader cooling network logic.
+ Paris "Cours Oasis": citywide programme—useful precedent for "distributed nodes" and continuity.
+ Space to Grow (Chicago): schoolyards as neighbourhood stormwater/green nodes (stepping-stone logic).

>>> Space to Grow, Chicago.



>>> Wander Wood - A loop of movement, Schoolyard in Denmark (VEGA landskab)

#7 Movement Networks & Loops

AIM Make health spatial: continuous, legible movement routes that connect arrivals > thresholds > play/learning > recovery, with exposure control (shade/rain/safety) built in.

DESIGN OBJECTIVES

+ **Continuous circulation:** safe, barrier-free movement loop(s) across route–edge–yard**.**
+ **Daily activity by design:** embed low-intensity movement into routines (arrive, queue, transition, play).
+ **Exposure control:** keep circulation usable under heat and rain (shade + dry footing + wind protection where needed).
+ **Equity:** the "best" route is the one everyone can use (not a premium path for a few).

CROSS-CUTTING CONSIDERATIONS

	Shaded, ventilated loops reduce radiant exposure during routines and transitions.
	Dry-foot continuity prevents route breakdown and access barriers after rain (no ponding on the primary loop).
	Routes can frame planting corridors without compacting soil volumes when edges and root zones are protected.
	Loops convert circulation into a daily dose of movement across ages and abilities.
	Accessible, safe loops distribute quality beyond "best corners" and reduce exclusion by ability/confidence.
	Supports autonomy, orientation, skill-building, and social interaction through legible, graded movement choices.

CORE INDICATORS

- ☐ **Loop continuity:** % of primary loop continuous and accessible (no breaks/ bottlenecks).
- ☐ **Conflict points:** number of high-conflict nodes (gate corners, blind bends, mixed speeds).
- ☐ **Shade continuity:** % of primary loop shaded in peak sun hours (qualitative + photo log).
- ☐ **Wet usability**: ponding/slip issues on the primary loop after rain (Y/N + location).
- ☐ **Width/clearance**: pinch points below minimum comfortable passing width (count).

#7 Movement Networks & Loops

METHODOLOGY

1 Connectivity Mapping

Define ecology as a spatial layer before choosing plants.

- Map sun/wind exposure, wet/dry zones, disturbance intensity (queues, play edges, shortcuts), and "quiet edges." Assign where ground–shrub–tree strata can survive school use, and where biodiversity must be protected by clear boundaries.

2 Continuity Building

Build a continuous living edge that stabilizes microclimate and habitat.

- Prioritize perimeters, route edges, and forecourts for layered bands: canopy trees + understory shrubs + groundcover/meadow pockets.
- Avoid monocultures and single-species rows; design continuity to reduce fragmentation and improve ecological function.

3 Dry-Feet Continuity (Access and usability)

Add habitat features as controlled, repeatable elements.

- Use microhabitats only where they can be protected and maintained: pollinator strips, deadwood/stone pockets, nesting boxes, "no-mow" patches, small shaded refuges.

4 Safety Detailing (Slip, slope, ponding control)

Use the building edge to add habitat and reduce heat stress.

- Where appropriate, integrate green façades, pergolas, and roof-based ecology (green/blue roof logic) with safe drainage and maintenance access. Keep daylight/ventilation logic intact and avoid creating damp, shaded "problem strips" at the base.

5 Hybrid Water Spaces (Learning + ecology, by design)

Use water visibly only where it is safe, shallow, and maintainable.

- Make stormwater legible: runnels/channels + visible inlets/outlets + planted retention that shows wet/dry cycles.
- Combine function: water square / floodable playcourt / rain-garden edge seating (clear boundaries, shallow depths).
- Protect performance: prevent soil compaction (root-zone protection, edging, zoning, maintenance access).

SCALE APPLICATION EXAMPLES

MACRO SCALE *Routes, crossings, public realm near schools*	Define safe school approach loops: continuous sidewalks, protected crossings, dry waiting, and shade on the last 200 m where exposure is highest.
MESO SCALE *Thresholds, forecourts, edges of premises*	Make the loop work at the interface: widen pinch points, separate queueing from through-movement, provide shaded and dry-foot waiting, and keep sightlines open at corners/doors/ramps.
MICRO SCALE *Schoolyard*	Build a primary inclusive loop + secondary activity circuits; keep fast play away from bottlenecks; embed micro-challenges beside (not on) accessible routes.

#7 Movement Networks & Loops

TRADEOFFS

+ **Activity vs safety:** separate fast/slow and protect sightlines at interfaces.
+ **Shade vs surveillance**: use high-canopy trees and permeable shade structures that keep visibility.
+ **Routes vs soil compaction:** protect rooting zones with edging and defined paths.

SOLUTIONS

+ Primary accessible loop (continuous paving + edge guidance)
+ Secondary running/play circuit (markings + resilient surface)
+ Shade spine (trees + canopies/pergolas at gaps)
+ Sheltered queue segment at entrances (canopy + wind/rain screen as needed)
+ Conflict-calming kit (widenings, corners, sightline openings, speed separation cues)

REFERENCES & EXAMPLES

REFERENCES

+ World Health Organization. (2020). WHO guidelines on physical activity and sedentary behaviour. WHO.
+ City of New York. (2025). Active Design Guidelines: Promoting physical activity and health in design.
+ Bull, F. C., et al. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. British Journal of Sports Medicine.

RELEVANT EXAMPLES

+ Wander Wood (Denmark, VEGA landskab): loop/route as a spatial organizer for daily movement.
+ Green Schoolyards America: many sites use "loop + stations" logic to distribute activity/inclusion.
+ Toyota Evergreen Learning Grounds: frequently integrates paths/loops with nature/play learning circuits.

>>> Wander Wood - A loop of movement, Schoolyard in Denmark (VEGA landskab)

>>> *Outdoor learning stations in Oasis project, Paris*

#8 Affordance Landscape & Outdoor Learning

AIM Design the space as a developmental environment: varied, legible affordances (move, manipulate, explore, cooperate) plus outdoor learning spaces that function under heat/rain constraints.

DESIGN OBJECTIVES

+ **Developmental range:** offer graded challenge for different ages/abilities (not one "play unit").
+ **Learning by space:** embed outdoor learning settings with comfort, visibility, and flexibility.
+ **Equity + inclusion:** affordances accessible in multiple ways (movement, sensory, social).
+ **Ecology as curriculum:** nature-contact is structured, safe, and durable (not decorative).

CROSS-CUTTING CONSIDERATIONS

	Learning and play require shade, cool-touch materials, and recovery options to remain usable during heat.
	Dry access and slip-safe surfaces keep outdoor learning and play operational during/after rain.
	Stewardship zones build habitat quality and durable nature-contact routines when soils and edges are protected.
	Diversified affordances increase participation and sustained movement across ages and genders.
	Multiple pathways to engage reduce exclusion by ability, confidence, or sensory needs.
	Supports autonomy, executive function, social learning, and risk competence through graded, legible challenge.

CORE INDICATORS

- ☐ **Affordance diversity**: presence of motor/sensory/social/autonomy affordances (Y/N + map).
- ☐ **Gradient quality:** at least 3 challenge levels per key affordance type (count).
- ☐ **Outdoor learning usability:** shade + seating + dry access + supervision (Y/N).
- ☐ **Nature-contact access:** % of children's daily route passing a stewardable nature zone.
- ☐ **Failure modes**: overheated surfaces / mud traps / inaccessible learning nodes (count).

#8 Affordance Landscape & Outdoor Learning

METHODOLOGY

1 *Affordance Mapping (needs + gaps)*

Start from user groups and routines.

- Map age bands, supervision lines, and where children actually gather/avoid.
- Identify missing affordance types: motor, sensory, social, autonomy/risk-competence.
- Locate "high value" zones: edges, shade lines, thresholds, quiet corners.

2 *Affordance Gradients (challenge by design)*

Build progression.

- Provide easy–medium–hard options for balance, climbing, running, and manipulation.
- Keep risk visible and manageable (no hidden fall traps, no ambiguous heights).
- Ensure alternatives for different abilities (parallel routes/ways to participate).

3 *Nature Contact and Stewardship (hands-on, durable)*

Link ecology to everyday practice.

- Use robust planting zones for observation and stewardship (garden strips, habitat edges).
- Specify soils and edging to survive school use (anti-compaction + clear boundaries).
- Integrate water/ecology only with hygienic, controlled design.

4 *Comfort and Safety (heat/rain constraints)*

Keep affordances functional in extremes.

- Place high-intensity play near shade + recovery nodes.
- Avoid mud traps at popular affordances; maintain slip-safe access to learning zones.

5 *Outdoor Learning Rooms (function-first)*

- Define at least one outdoor classroom: shade, seating logic, acoustic buffering, storage.
- Provide "micro-studios": small group tables, observation spots, maker corners.
- Ensure all-weather usability: shade + partial rain cover + dry footing.

SCALE APPLICATION EXAMPLES

MACRO SCALE *Routes, crossings, public realm near schools*	Link school routes with "learning moments": observation points, biodiversity stepping stones, shaded waiting that supports orientation and calm.
MESO SCALE *Thresholds, forecourts, edges of premises*	Create threshold learning edges: planted forecourts, outdoor notice/learning walls, shaded micro-studios near entrances and building interfaces.
MICRO SCALE *Schoolyard*	Deliver the full affordance landscape: gradients, outdoor classroom(s), stewardship zones, and safe, legible risk-taking in supervised sightlines.

#8 Affordance Landscape & Outdoor Learning

TRADEOFFS

+ **Risk competence vs safety:** keep risk graded, legible, and maintainable.
+ **Nature contact vs durability:** protect soils/edges and choose robust palettes.
+ **Learning vs circulation:** place learning nodes beside desire lines without blocking flow.

SOLUTIONS

+ Outdoor classroom kit (shade canopy/pergola + seating + storage)
+ Affordance gradient set (stepping/balance edges, climbable topography, loose-parts zone)
+ Stewardship strips (raised planters/garden beds + habitat edge)
+ Micro-studios (small tables/benches in shade + wind buffer)
+ All-weather detailing (dry access, slip-safe surfaces, edge containment)

REFERENCES & EXAMPLES

REFERENCES

+ Herrington, S., & Brussoni, M. (2015). The importance of play and nature-based play spaces for children's health and development. Current Obesity Reports.
+ Natural Learning Initiative. (2013). Best Practices of Outdoor Learning Environments. NC State University.
+ Mårtensson, F., et al. (2009). Outdoor environmental assessment of attention-promoting settings for preschool children. Health & Place.

RELEVANT EXAMPLES

+ Paris "Cours Oasis": outdoor learning + climate comfort retrofits (legible, repeatable kits).
+ Toyota Evergreen Learning Grounds: "ecology as curriculum" + stewardship + diverse affordances.
+ Green Schoolyards America: nature-based affordance patterns + learning landscapes across age groups.

>>> Variety of affordances, Oasis project, Paris

>>> *TouchWood-playground-quiet-area, UK*

#9 Comfort Nodes & Restorative Micro-Spaces

AIM Build a network of small, reliable recovery spaces (cool, calm, legible) that support regulation, inclusion, and sustained outdoor time.

DESIGN OBJECTIVES

+ **Recovery availability:** a comfort node within short reach of high-intensity zones and entrances.
+ **Thermal refuge:** reduce radiant load and provide cool surfaces + airflow where possible.
+ **Sensory regulation:** quiet, low-conflict micro-spaces for decompression and social choice.
+ **Equity:** comfort is distributed, not reserved for a "best corner."

CROSS-CUTTING CONSIDERATIONS

	Provides thermal refuge and reduces heat stress during routines and outdoor time.
	Dry nodes reduce slip risk and keep outdoor time possible during/after rain.
	Planted comfort nodes can support microhabitats and evapotranspiration when soils are protected.
	Recovery enables longer active periods and better pacing (less avoidance and dropout).
	Distributed comfort supports vulnerable users.
	Supports self-regulation, autonomy, and social choice through legible calm micro-spaces.

CORE INDICATORS

- ☐ **Node coverage:** maximum distance to a comfort node from play cores/entrances(m).
- ☐ **Shade reliability:** % of nodes shaded in peak hours (qualitative + photo log).
- ☐ **Surface safety:** overheated seating/ground or slippery wet surfaces (Y/N + location).
- ☐ **Use diversity:** presence of solo/pair/small-group options per node (count).
- ☐ **All-weather access:** dry-foot access to nodes after rain (Y/N).

#9 Comfort Nodes & Restorative Micro-Spaces

METHODOLOGY

① *Comfort Mapping (exposure + demand)*

Start from user groups and routines.

- Identify heat/rain exposure hotspots (queues, play cores, south edges, reflected façades).
- Map noise/conflict hotspots and withdrawal needs.
- Select node locations along the gate–door–yard spine and main loop.

② *Microclimate Design (shade + surfaces + air)*

Comfort matters.

- Prioritize high shade quality (tree canopy or effective overhead shade).
- Specify cool-touch seating surfaces and ground (avoid heat-storing finishes).
- Use planting and form to support airflow while avoiding trapped heat.

③ *Sensory and Social Choice (calm without isolation)*

Link ecology to everyday practice.

- Provide small "in-between" spaces: 1–3 person nooks + small group zones.
- Maintain visibility lines; avoid hidden pockets.
- Offer sensory variety (texture, planting, filtered light) without barriers.

④ *All-Weather Reliability (rain + maintenance)*

Nodes must work every day.

- Keep dry access and stable footing (no mud funnels).
- Provide partial cover where waiting is unavoidable (entrances, pickup points).
- Use durable details: cleanable seating, robust edges, simple maintenance logic.

⑤ *Building Interface (indoor–outdoor comfort)*

Treat the façade zone as part of comfort.

- Control reflected radiation near walls (shade devices, planted buffers).
- Provide shaded outdoor waiting that reduces indoor overheating loads at entrances.

SCALE APPLICATION EXAMPLES

MACRO SCALE *Routes, crossings, public realm near schools*	Add comfort on routes: shaded waiting at stops/crossings, small refuges on the last 200 m, and legible calm points near traffic.
MESO SCALE *Thresholds, forecourts, edges of premises*	Design comfort at thresholds and along façades: shaded queues, planted buffers, reduced glare/reflection, and sheltered micro-spaces that ease arrival.
MICRO SCALE *Schoolyard*	Create a network of nodes: near intense play, near learning, near quiet edges—each with shade, cool surfaces, and dry access.

#9 Comfort Nodes & Restorative Micro-Spaces

TRADEOFFS

+ **Refuge vs supervision**: keep calm spaces visible and well-lit.
+ **Shade vs winter sun:** mix deciduous canopy and adjustable shade devices.
+ **Planting vs maintenance:** use robust palettes and protect soils from compaction.

SOLUTIONS

+ Shade + seating module (tree canopy / canopy / pergola + cool-touch bench)
+ Calm nook kit (low edge, planting buffer, small-scale seating)
+ Entrance queue shelter (canopy + wind/rain screen as needed)
+ Façade radiation control (louvers/overhangs + planted buffer strip)
+ Dry-access detailing (slip-safe surfaces + drainage away from seating zones)

REFERENCES & EXAMPLES

REFERENCES

+ Evergreen. (2024). Landscape and child development: Guidelines for outdoor learning and play environments. Evergreen Canada.
+ Green Schoolyards America. (n.d.). Inclusive design for outdoor spaces (sensory regulation + calming nature input in school grounds). Green Schoolyards America.
+ Center for Green Schools. (2020). Outdoor learning spaces design guide. U.S. Green Building Council.

RELEVANT EXAMPLES

+ Barcelona "Climate Shelters" (schools as cool islands): shade + water + greenery to create reliable cooling/refuge spaces for children and communities.
+ Paris "Cours Oasis" schoolyard programme: transforming sealed yards into green/cool schoolyards (usable calm/comfort pockets + climate function).
+ OASIS Schoolyards (UIA / programme case documentation): schoolyards as "cool islands" with design measures supporting comfort + inclusion.

>>> Quite green corners, Groenblauwe schoolplein, The Netherlands.

>>> *Adapting outdoor spaces for users with needs, Green Schoolyards America*

#10 Universal Access

AIM Go beyond compliance: continuous, legible, safe access that supports independence, choice, and equal quality across all routes and zones.

DESIGN OBJECTIVES

+ **Continuous access:** barrier-free spine from public realm to all key functions (not "one accessible corner").
+ **Equal quality:** accessible routes are also the most comfortable (shade, surfaces, seating, safety).
+ **All-weather reliability:** no breakdown under rain/heat (dry-feet + slip resistance + thermal comfort).
+ **Dignified participation:** multiple ways to join play/learning without segregation.

CROSS-CUTTING CONSIDERATIONS

	Shade and cool, restorative areas ashould be accessible infrastructure.
	Dry-feet continuity prevents exclusion after rain.
	Protect soils while keeping access firm (clear edges, root-zone protection).
	Accessible loops increase daily movement for all abilities.
	Ensures equal comfort/safety.
	Supports autonomy, confidence, and independent mobility.

CORE INDICATORS

- ☐ **Continuity:** % of key destinations reachable via barrier-free route (map-based).
- ☐ **Break points:** count of slope/surface/width/ponding failures on the spine.
- ☐ **Thermal equity:** shade coverage of accessible routes + waiting (qualitative).
- ☐ **Slip/wet safety:** slip risks on ramps/landings after rain (Y/N).
- ☐ **Inclusive participation**: number of key play/learning zones with accessible engagement options.

#10 Universal Access

METHODOLOGY

1. *Access Mapping (continuity + barriers)*

Explore the journey.

- Map the gate–door–yard accessible route and key destinations.
- Identify breaks: slopes, cambers, surface discontinuities, narrowings, clutter, ponding.
- Map "forced exposures" (unshaded queues, overheated surfaces, wind tunnels).

2. *Continuity*

Make one route that always works.

- Provide a continuous, firm, slip-safe primary spine with passing points.
- Keep tactile/sensory zones adjacent, not on the spine.
- Ensure direct access to comfort nodes and learning spaces.

3. *Treshold & Building interface*

Link ecology to everyday practice.

- No ponding or abrupt level changes at doors/ramps/landings.
- Control glare and reflected heat at façades and entrance aprons.
- Provide sheltered waiting and clear door approach zones.

4. *Inclusive Participation (access to play/learning)*

Design alternatives, not exceptions.

- Provide parallel ways to engage: seated play, sensory edges, reachable elements, social platforms.
- Maintain clear sightlines for caregivers/teachers and independent navigation.

5. *Wayfinding (legibility, not signage overload)*

Make routes readable.

- Use consistent edge cues, surface hierarchy, lighting, and landmark nodes.
- Avoid clutter: furniture placed off the clear path with defined zones.

SCALE APPLICATION EXAMPLES

MACRO SCALE *Routes, crossings, public realm near schools*	Guarantee accessible approach routes, safe crossings, dry waiting, and shaded last-200-m segments used by walkers and transit users
MESO SCALE *Thresholds, forecourts, edges of premises*	Make entrances dignified: stable gradients, slip-safe landings, shaded queues, and façade zones that avoid glare/overheating and ponding.
MICRO SCALE *Schoolyard*	Create an accessible schoolyard with inclusive loops and participation: clear hierarchy, comfort nodes on-route, and parallel affordances.

#10 Universal Access

TRADEOFFS

+ **Permeability vs firm access**: place infiltration adjacent with clear edge containment.
+ **Texture vs mobility:** keep tactile richness off the primary spine.
+ **Shade structures vs clearance:** design canopies/pergolas with clear heights and uncluttered paths.

SOLUTIONS

+ Accessible primary spine (firm surface + passing points + clear edges)
+ Threshold package (slip-safe landings, drainage, sheltered queue)
+ Façade comfort controls (overhangs/louvers + planted buffer)
+ Inclusive play/learning interfaces (platform edges, reachable elements, seated participation)
+ Wayfinding kit (landmark nodes + consistent surface hierarchy + lighting)

REFERENCES & EXAMPLES

REFERENCES

+ CEN. (2021). EN 17210:2021 Accessibility and usability of the built environment—Functional requirements. European Committee for Standardization.
+ International Organization for Standardization. (2011). ISO 21542:2011 Building construction—Accessibility and usability of the built environment. ISO.

RELEVANT EXAMPLES

+ Green Schoolyards America: strong practice-base on inclusive outdoor spaces (beyond minimum compliance).
+ Boston Schoolyard Initiative: long-term programme; many retrofits explicitly solve access continuity at yard/threshold interfaces.
+ Paris "Cours Oasis": repeated "threshold + yard" upgrades—useful as a reference set for accessible, all-weather school entrances

>>> Adapting outdoor spaces for users with needs, Green Schoolyards America

#11 Topography

AIM Use topography as a multi-tool: play + microclimate + water control + habitat, with safe gradients and maintainable edges.

DESIGN OBJECTIVES

+ **Play value:** graded landforms that support movement, challenge, and imagination.
+ **Microclimate:** create shade opportunities, wind moderation, and cooler ground zones.
+ **Stormwater performance**: direct, slow, store, and infiltrate water with landform logic.
+ **Habitat & soil:** protect and build living soil volumes, not thin planted veneers

CROSS-CUTTING CONSIDERATIONS

	Landforms support planting and comfort zoning; require shade pairing.
	Topography can store/route water safely, reduce ponding, and enable infiltration when overflow is controlled.
	Increases habitat diversity and soil volumes when landforms are vegetated and protected from compaction.
	Supports climbing, running, balance, and varied movement through graded terrain.
	Graded options prevent exclusion by ability/confidence through accessible alternatives and safe gradients.
	Supports risk competence, motor development, and imaginative play via legible challenge.

CORE INDICATORS

- ☐ **Gradient compliance:** slopes and transitions appropriate for access and safety (map + check).
- ☐ **Water behavior:** ponding/erosion performance after rain (Y/N + location).
- ☐ **Soil viability:** evidence of compaction/plant failure on landforms (Y/N).
- ☐ **Use integration:** landforms connected to loops and comfort nodes (Y/N).
- ☐ **Edge safety:** clear, maintainable edges at changes in level (Y/N).

#11 Topography

METHODOLOGY

1 *Landform Mapping (flows + use)*

Start from water and movement.

- Map runoff paths and low points; set “safe wet” vs “must stay dry” zones.
- Map desire lines and supervision lines; avoid landforms that create hidden conflicts.
- Define required gradients for access and maintenance.

2 *Diverse Topography*

Design progression.

- Provide small/medium/large landforms with accessible alternatives.
- Keep slopes legible; avoid ambiguous edges and uncontrolled drop-offs.
- Integrate seating edges and pause points into landforms.

3 *Microclimate Shaping (shade + exposure control)*

Landform should improve comfort.

- Use berms and planting to reduce wind exposure where needed.
- Pair topography with canopy for effective radiant control (landform alone isn’t shade).
- Avoid heat traps against hard walls; use planted buffers.

4 *Water-Integrated Forms (slow–store–soak by geometry)*

Design alternatives, not exceptions.

- Use swales, basins, and gentle depressions for safe detention and infiltration.
- Design controlled overflow routes away from desire lines.
- Protect high-contact zones from contaminated runoff.

5 *Wayfinding (legibility, not signage overload)*

Make routes readable.

- Use consistent edge cues, surface hierarchy, lighting, and landmark nodes.
- Avoid clutter: furniture placed off the clear path with defined zones.

SCALE APPLICATION EXAMPLES

MACRO SCALE *Routes, crossings, public realm near schools*	Use modest landform interventions where feasible (swales/berms in verges, curb extensions) to support runoff control and comfort on routes.
MESO SCALE *Thresholds, forecourts, edges of premises*	Shape forecourts and building edges: micro-berms, gentle falls, and planted buffers that control runoff and reduce reflected heat near façades.
MICRO SCALE *Schoolyard*	Create the full topographic system: play landforms, infiltration swales, seating edges, and connected gradients integrated with loops and learning zones.

#11 Topography

TRADEOFFS

+ **Topography vs access:** provide alternative routes and keep critical spines within safe gradients.
+ **Detention vs safety:** keep “wet zones” shallow, visible, and separated from key desire lines.
+ **Landform vs maintenance:** design erosion-resistant edges and repairable surfacing.

SOLUTIONS

+ Berms + seating edges (graded landforms with pause points)
+ Swales / infiltration basins (shallow, visible, controlled overflow)
+ Terraced play slopes (durable edges + accessible alternatives)
+ Planted buffers at façades (reduces reflection + manages runoff)
+ Erosion control kit (stable transitions, edge containment, repairable surfaces)

REFERENCES & EXAMPLES

REFERENCES

+ Woods Ballard, B., et al. (2015). The SuDS Manual (C753). CIRIA.
+ Herrington, S., & Brussoni, M. (2015). Nature-based play spaces and children’s health/ development. Current Obesity Reports.
+ International Organization for Standardization. (2011). ISO 21542:2011 – Accessibility and usability of the built environment. ISO.

RELEVANT EXAMPLES

+ Water Square Benthemplein (Rotterdam): landform as storage + public use precedent (clear “safe wet / must stay dry” logic).
+ Space to Grow (Chicago): frequent use of shallow basins/swales + edges for durable school use.
+ Wander Wood (Denmark): topography + loop structure supporting movement and play gradients.

>>> Example of topography design of a playgroud.

This toolkit is provided as an annex to the PhD thesis **REACTIVE** -Framework for the design of **R**esilient, h**E**althy, **ACT**ive, and **I**nclusive school-related en**V**ironm**E**nts.

It is intended as an operational support for architects, municipalities, and school communities to translate the research findings into design actions across the macro, meso, and micro scales.

The toolkit is designed to be read and used together with the thesis, which documents the analytical framework, definitions, and underlying evidence base. In particular, the complete indicator registry (full list, methodologies, and data sources) and the expanded best-practice catalogue (case descriptions, references, and selection rationale) are presented in the main thesis volume.

This annex does not replace detailed technical design, local regulations, or specialist assessment; it provides a structured guide for early-stage decision-making and integrated design reasoning.

Antonia Sore

Closing note.

UNIVERSITÀ
DEGLI STUDI
FIRENZE

Da un secolo, oltre.