

An abstract artwork composed of various layers of paper in shades of brown, tan, and cream, torn and layered to create a textured, organic form. The layers are irregular and overlapping, with some showing fine lines and textures from the paper's grain. The overall effect is one of depth and complexity, suggesting multiple layers of meaning or structure.

Layers of resilience

*Empowering ecological dynamics to
strengthen the built environment*

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Faculty of Architecture and the Built Environment
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Design tutor: Thomas Offermans
Building technology tutor: Paddy Tomesen*

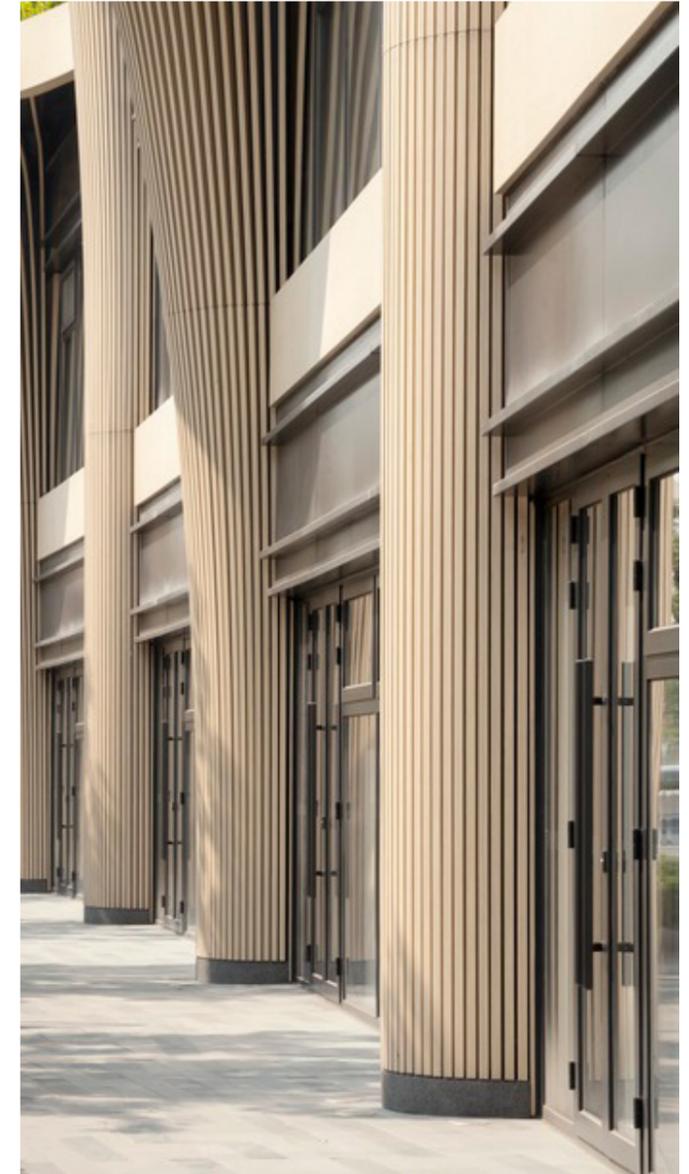
Building of the year 2024 winners - ArchDaily



On Labs - New Global Headquarters for On running / Specific Generic + Spillmann Echsle Architekten



Parish of the Holy Family / ARQBR Architecture and Urbanism



Solar Trees Marketplace / Koichi Takada Architects

*“The whole idea of architecture is **permanence**. (...) It is an **illusion**.” (Brand, 1994, p.16-17)*

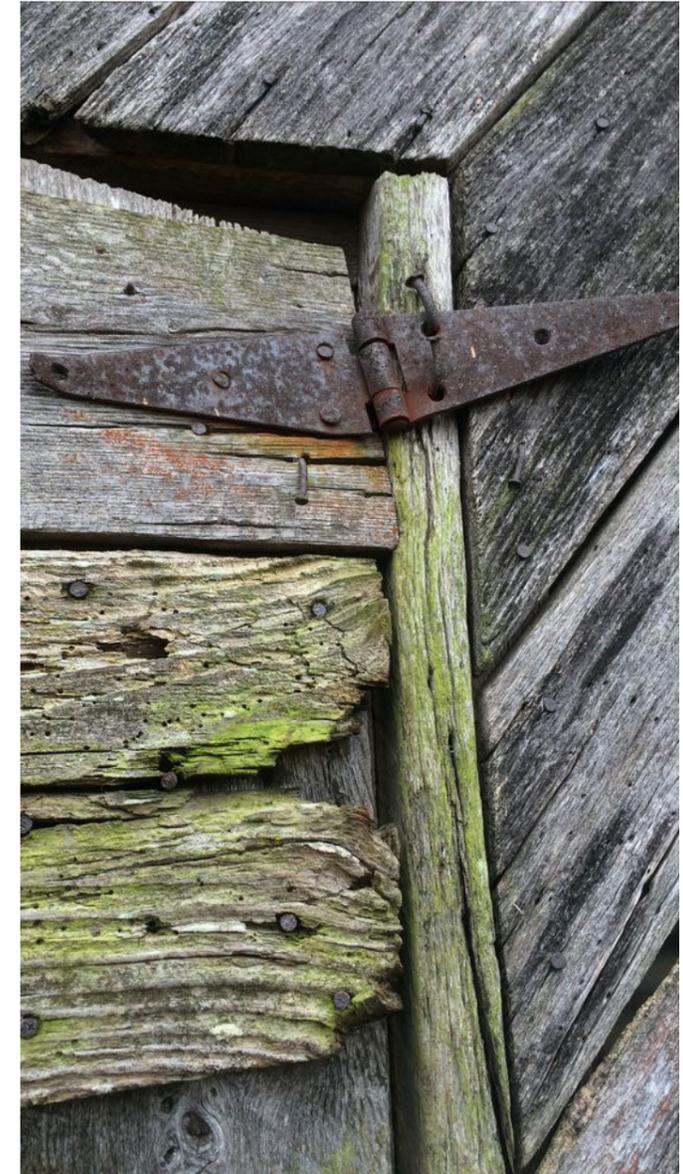
The built environment is a dynamic entity



Old farmhouse in Iceland

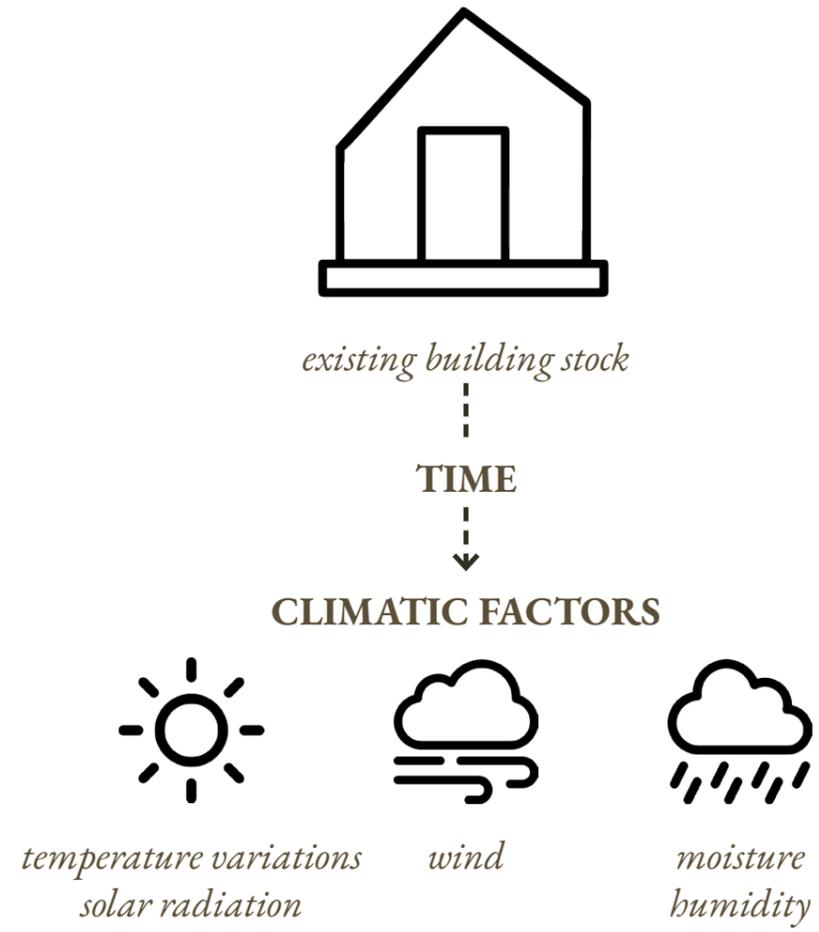


Old building in Donzenac, France

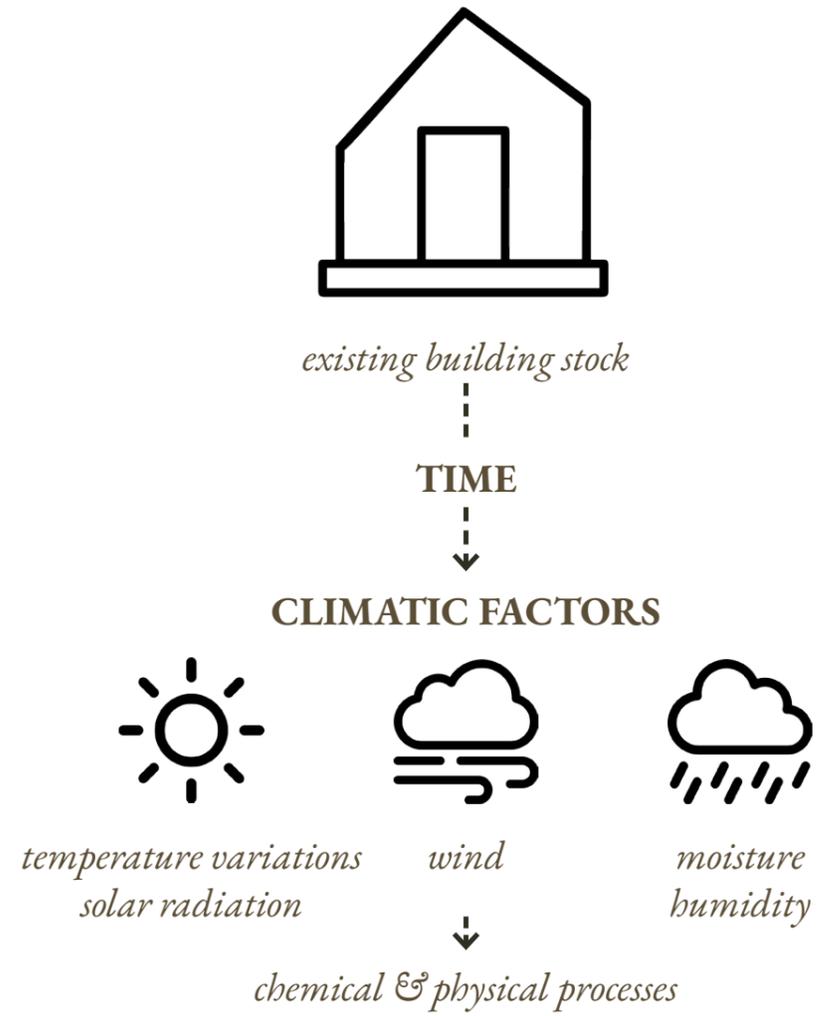


Decayed timber door

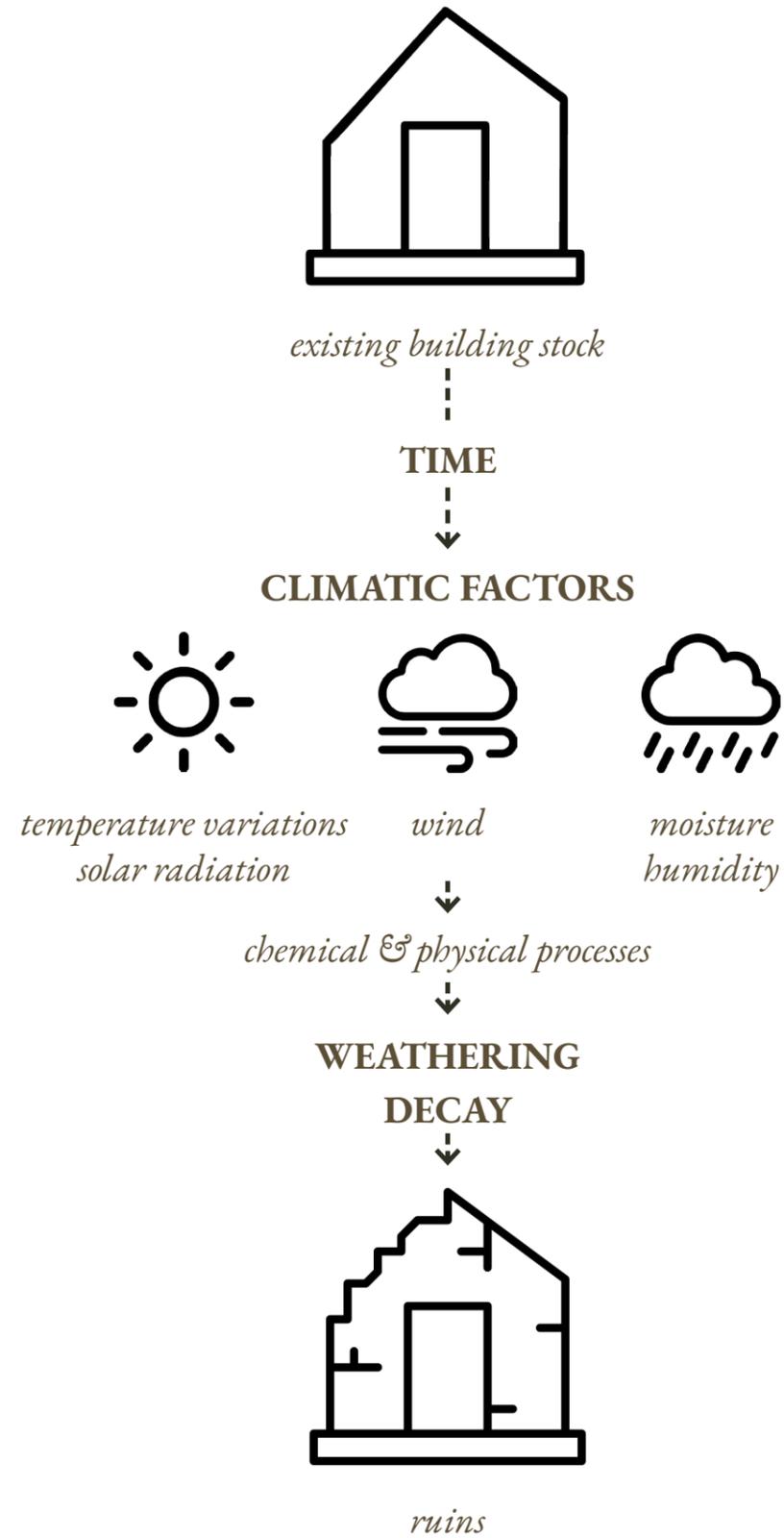
The built environment is a dynamic entity



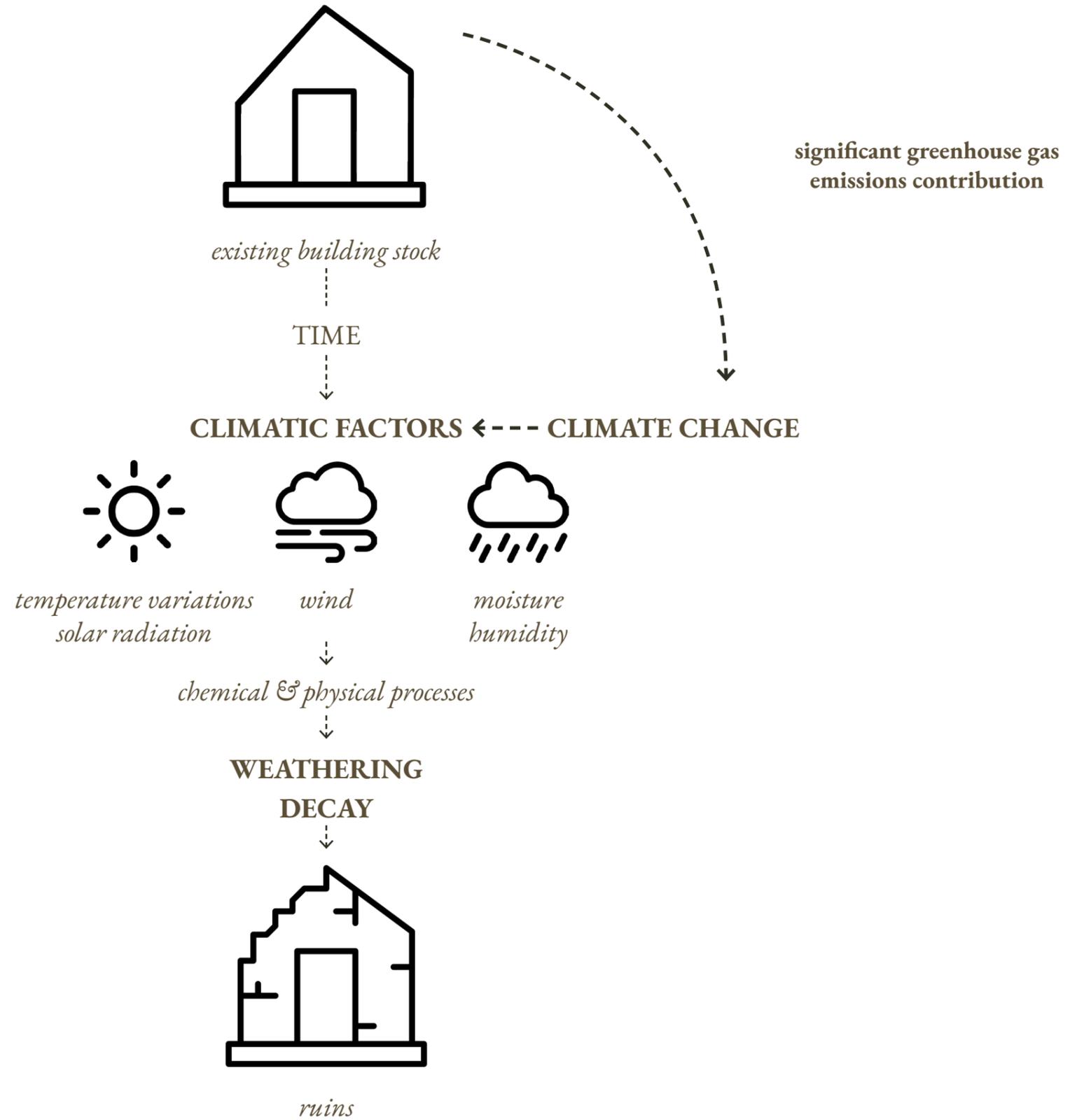
The built environment is a dynamic entity



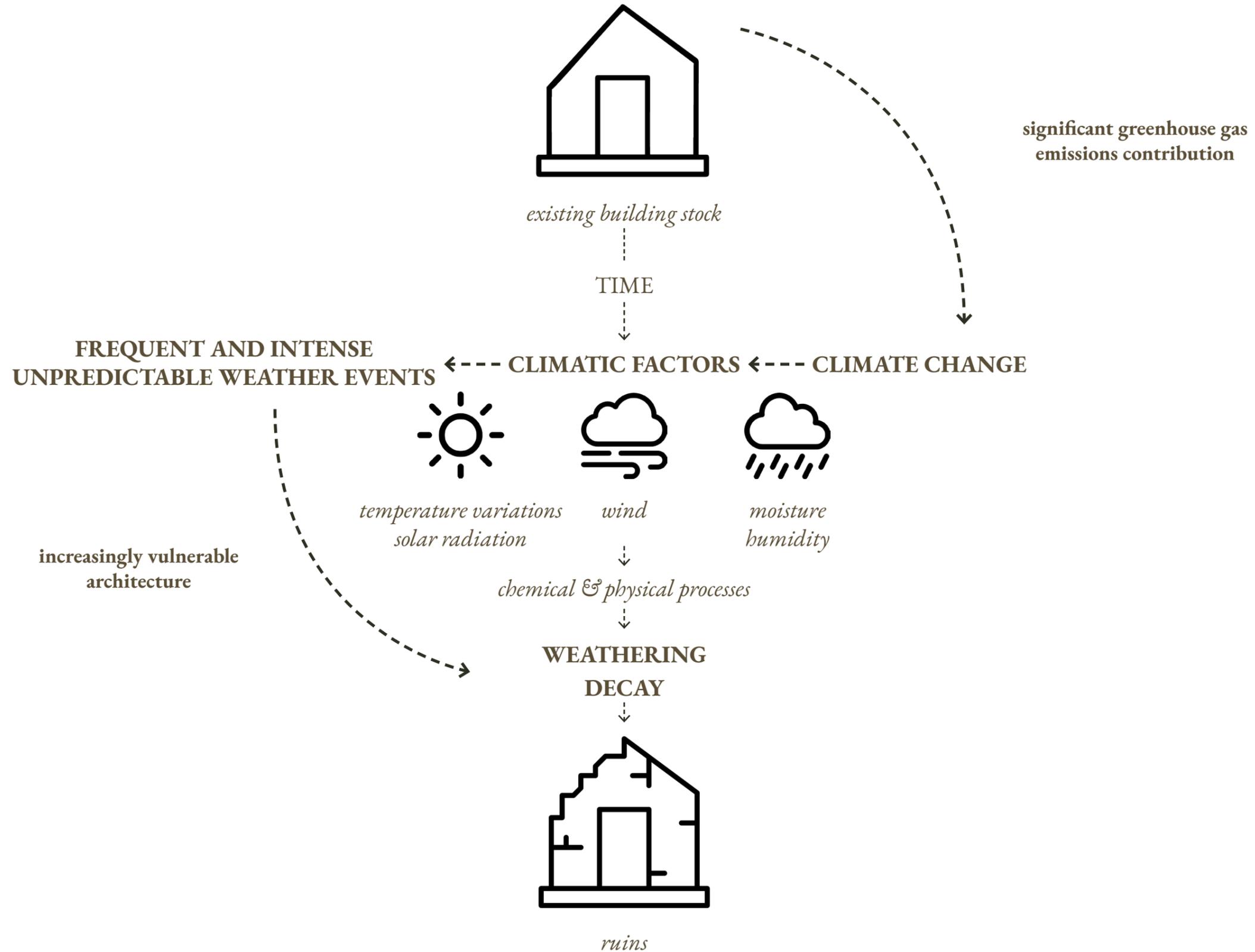
The built environment is a dynamic entity



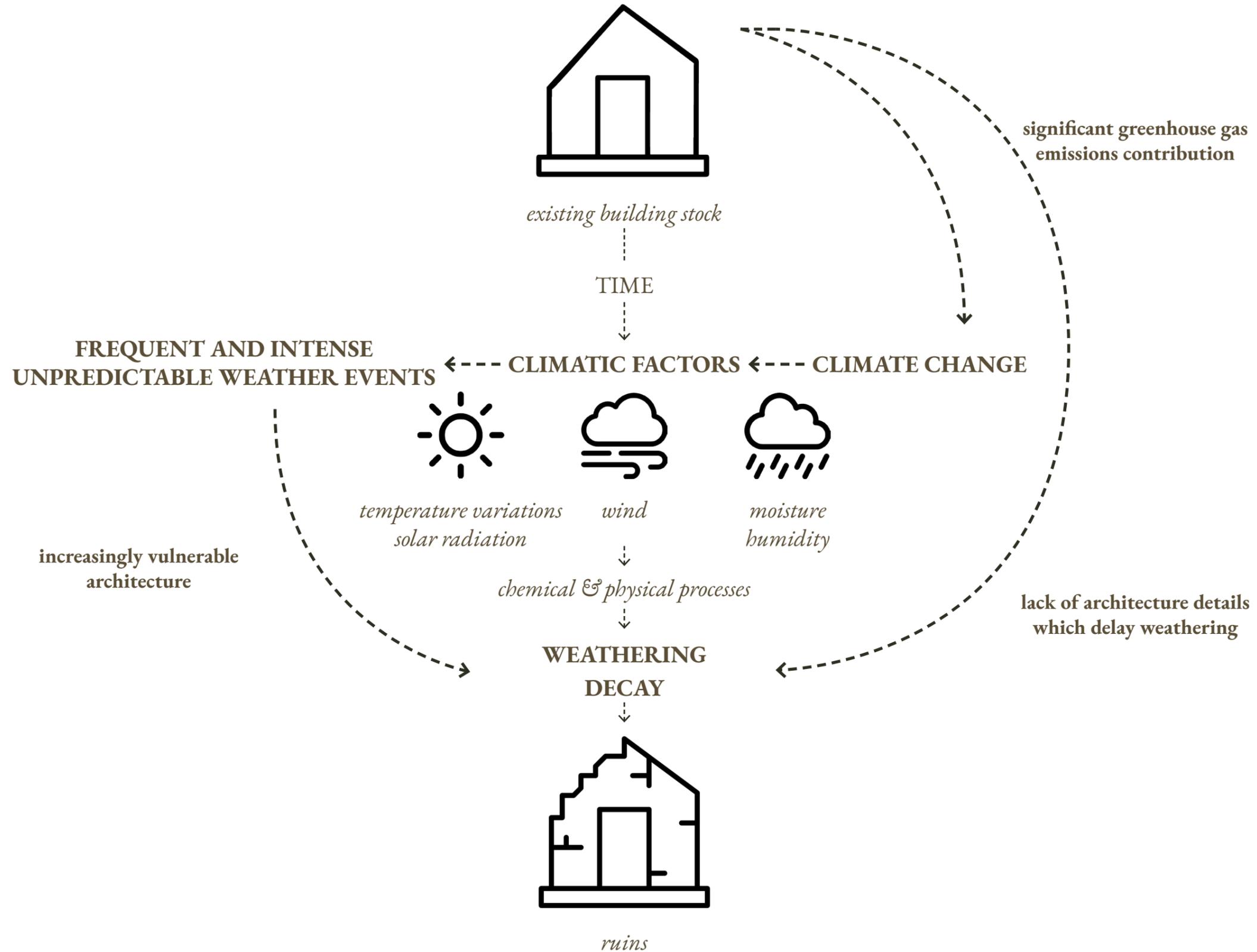
The built environment is a dynamic entity



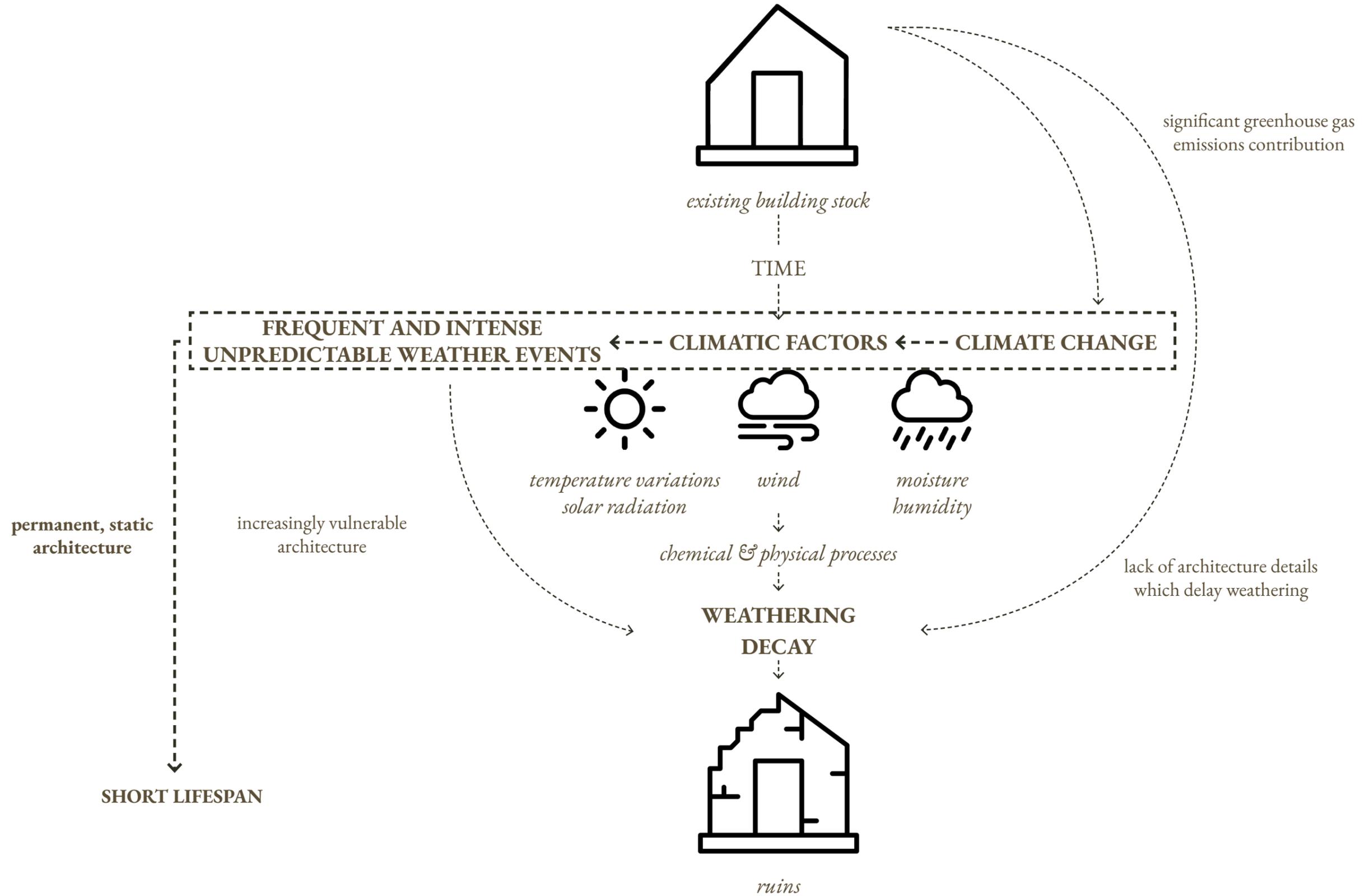
The built environment is a dynamic entity



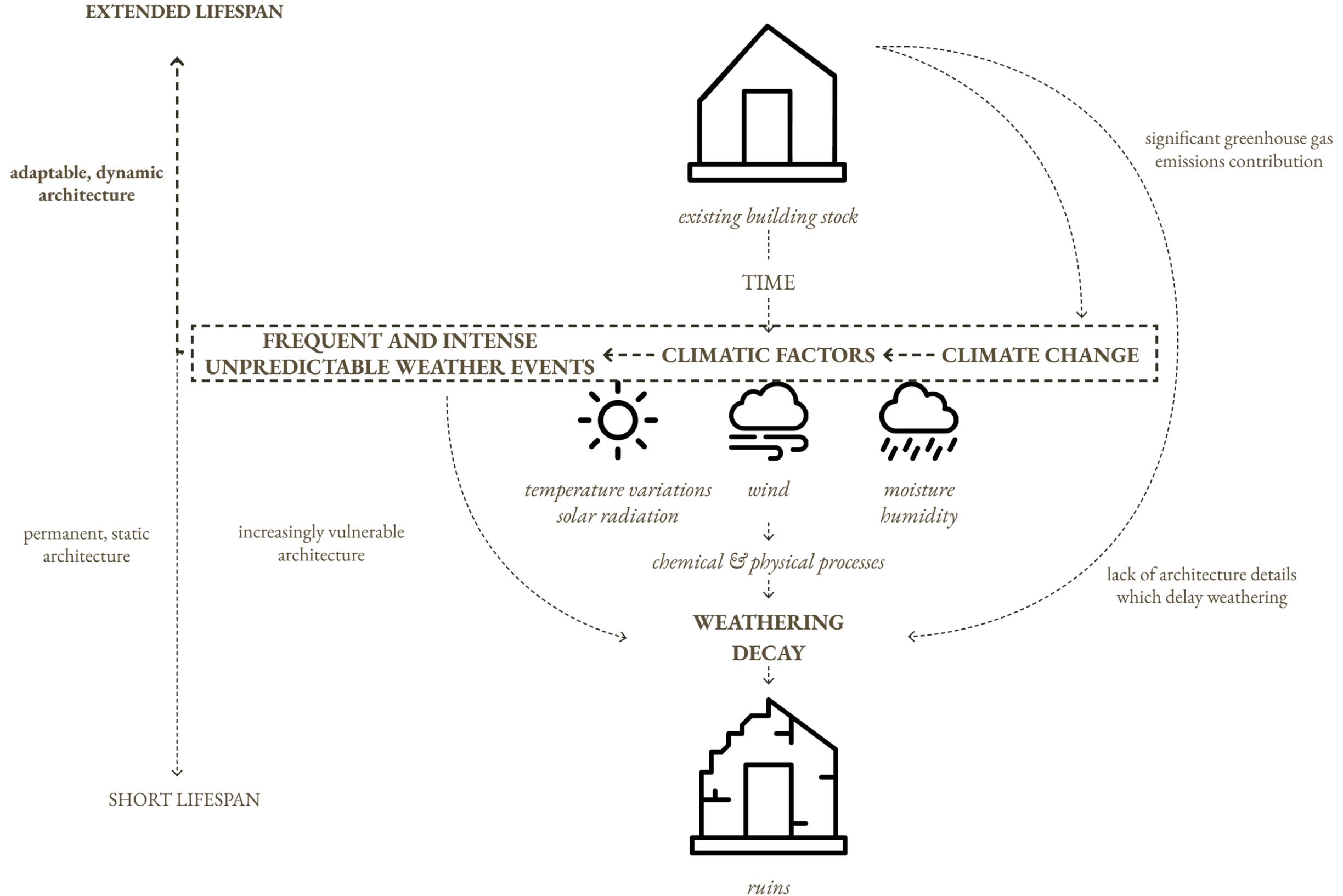
The built environment is a dynamic entity



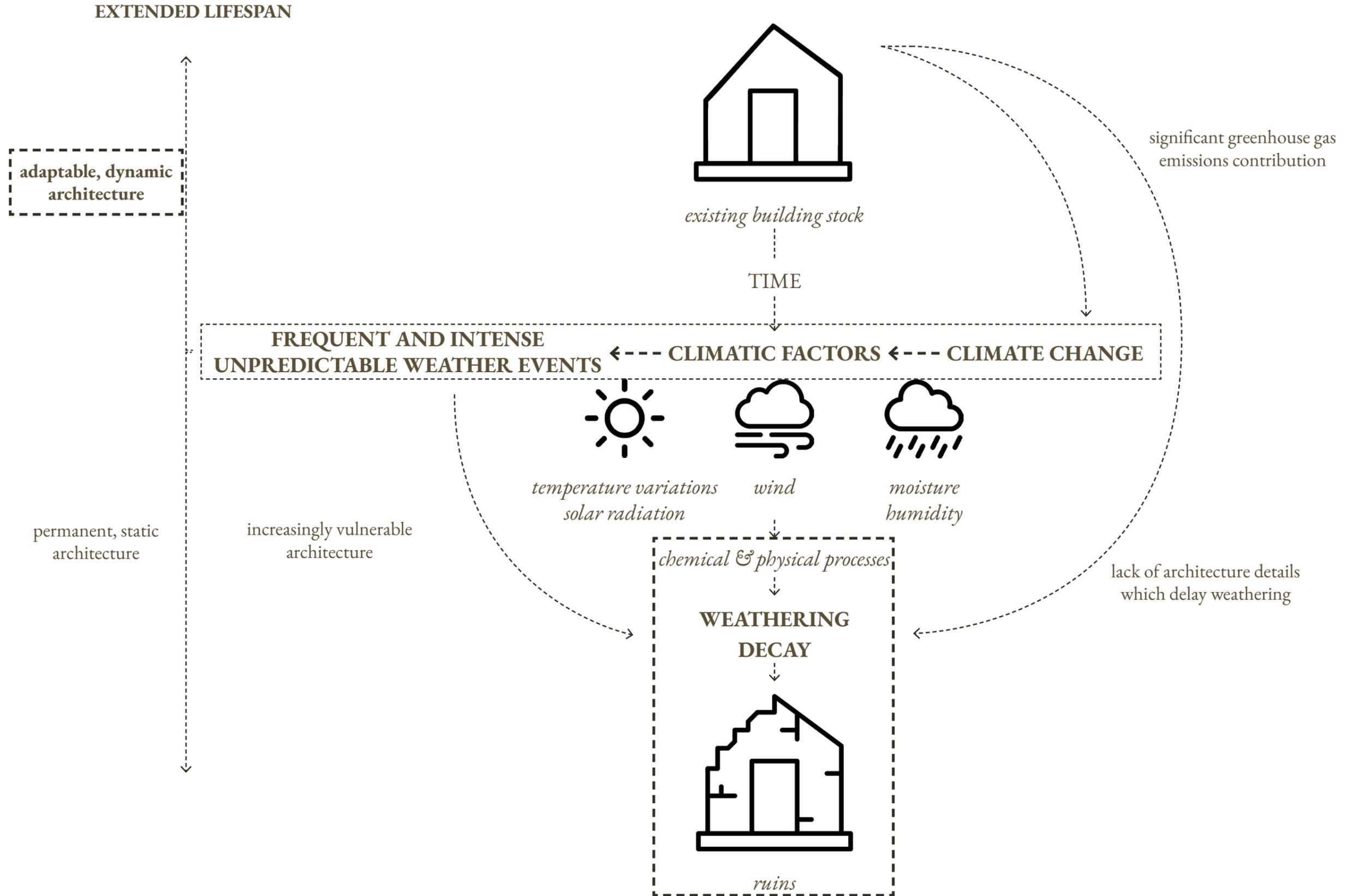
Longevity is a matter of adaptability



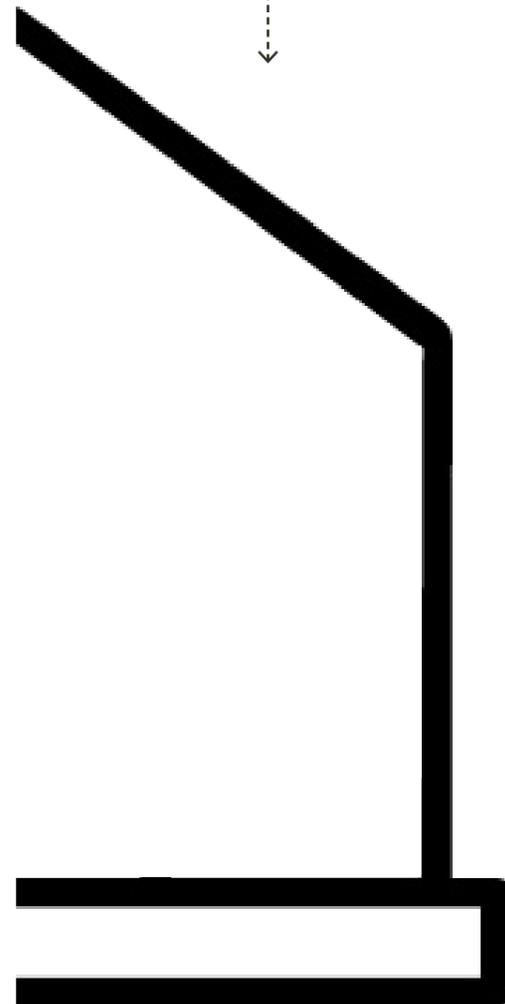
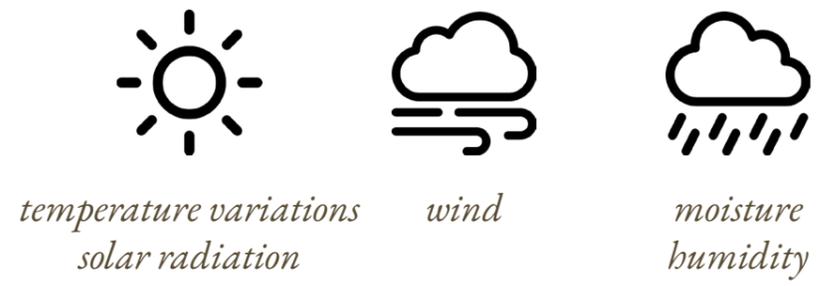
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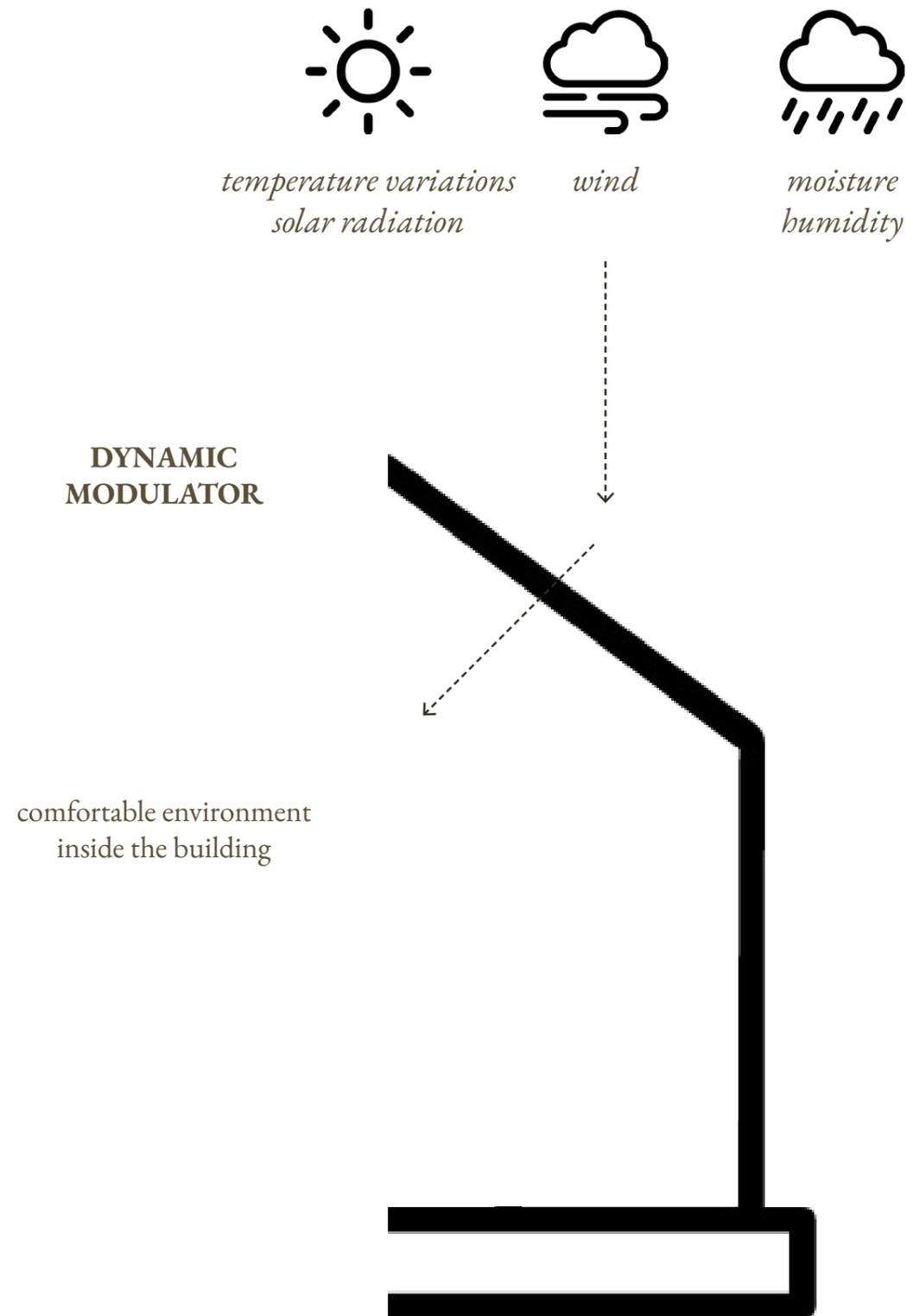
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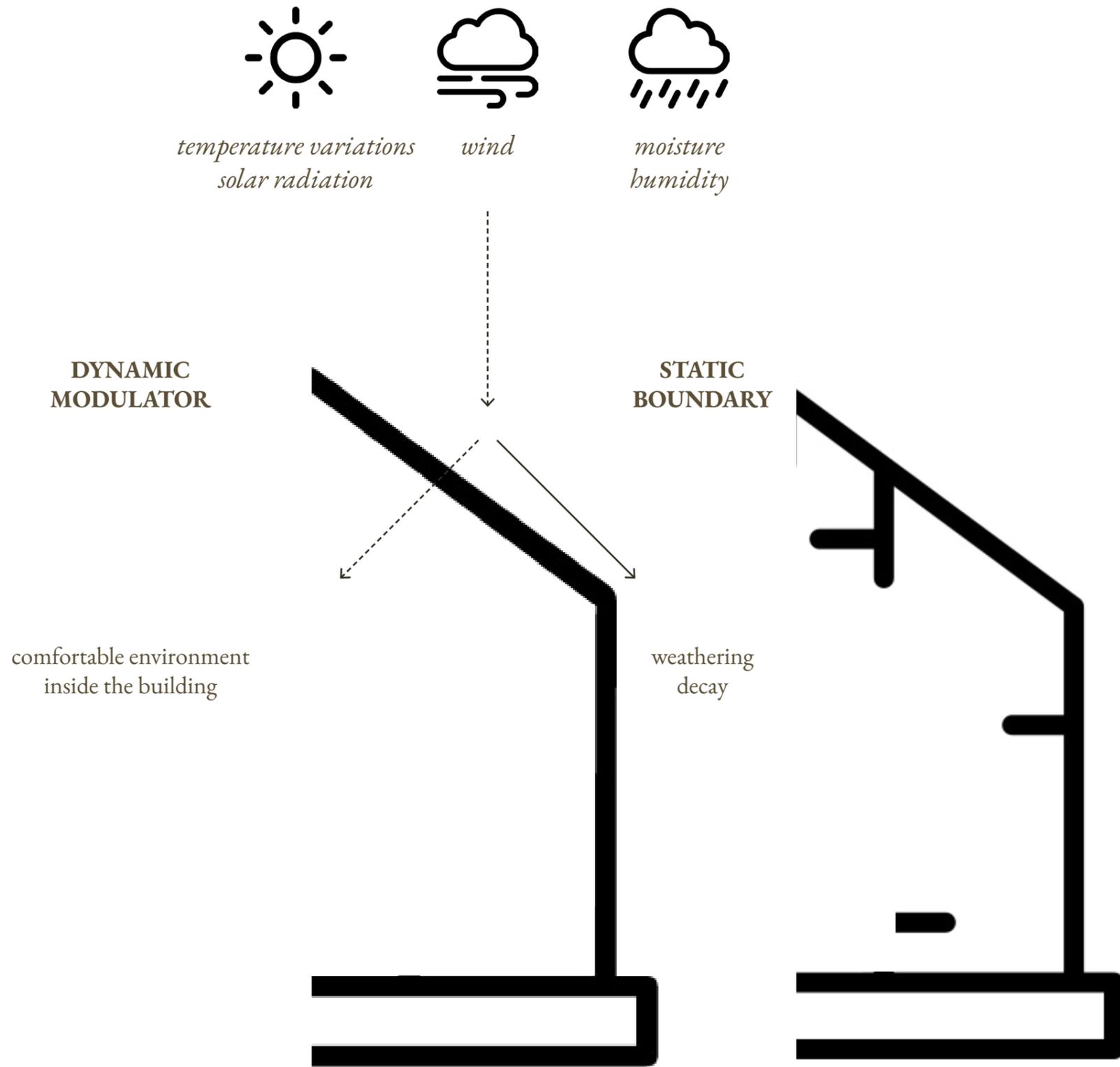
Building skin as a modulator vs. as a boundary



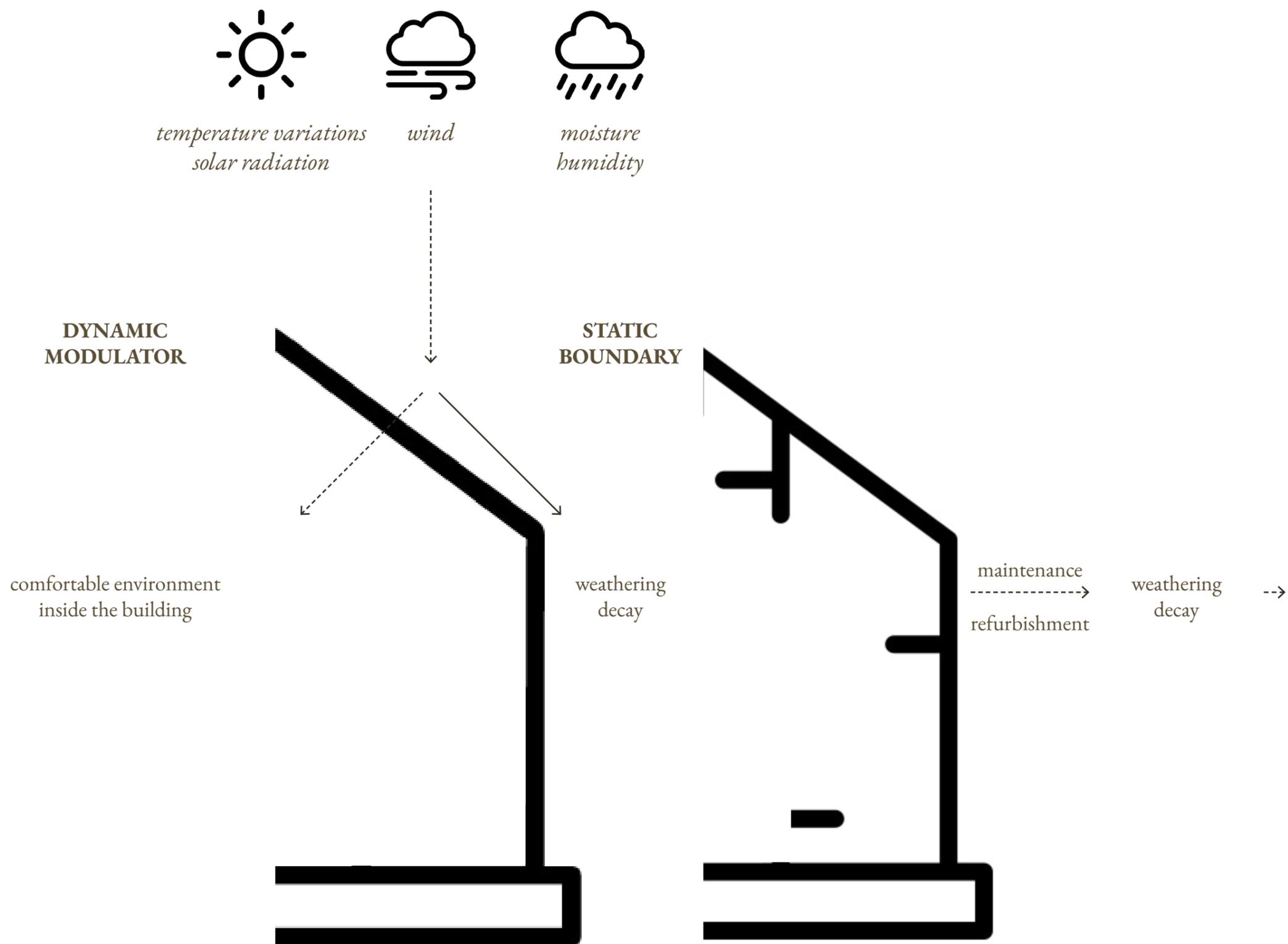
Building skin as a modulator vs. as a boundary



Building skin as a modulator vs. as a boundary

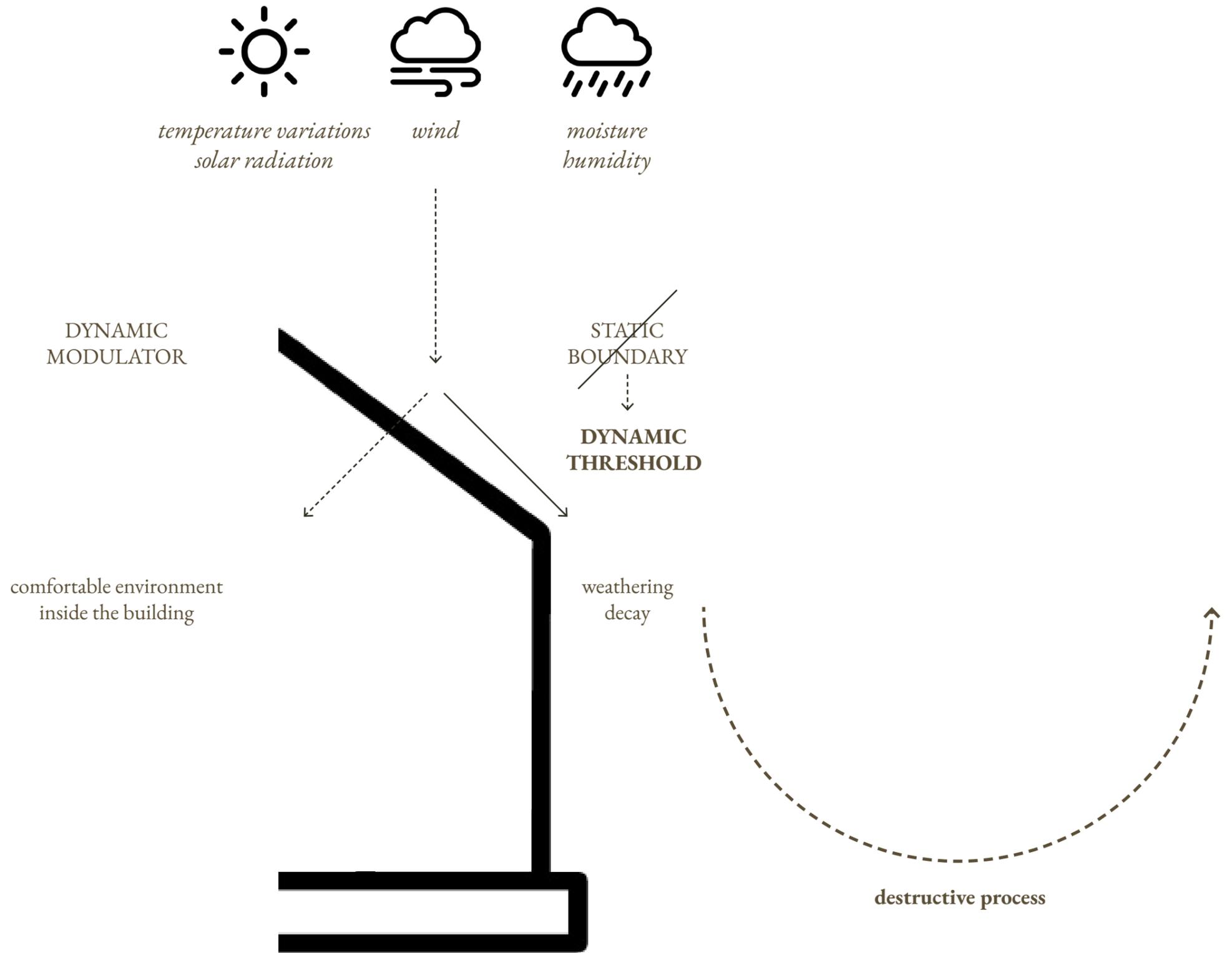


Building skin as a modulator vs. as a boundary

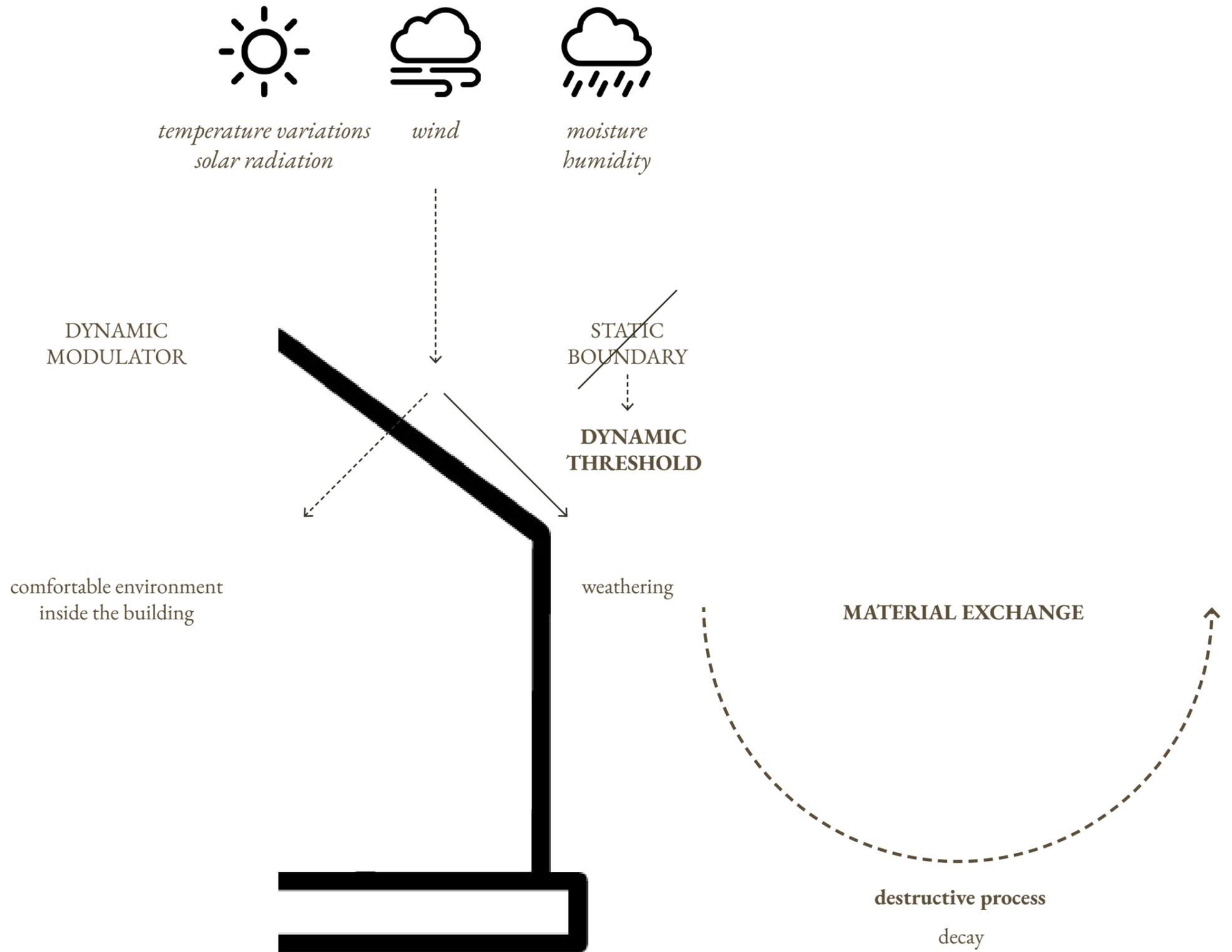


*“Finishing ends construction, **weathering constructs finishes.**” (Mostafavi & Leatherbarrow, 1993, p.5)*

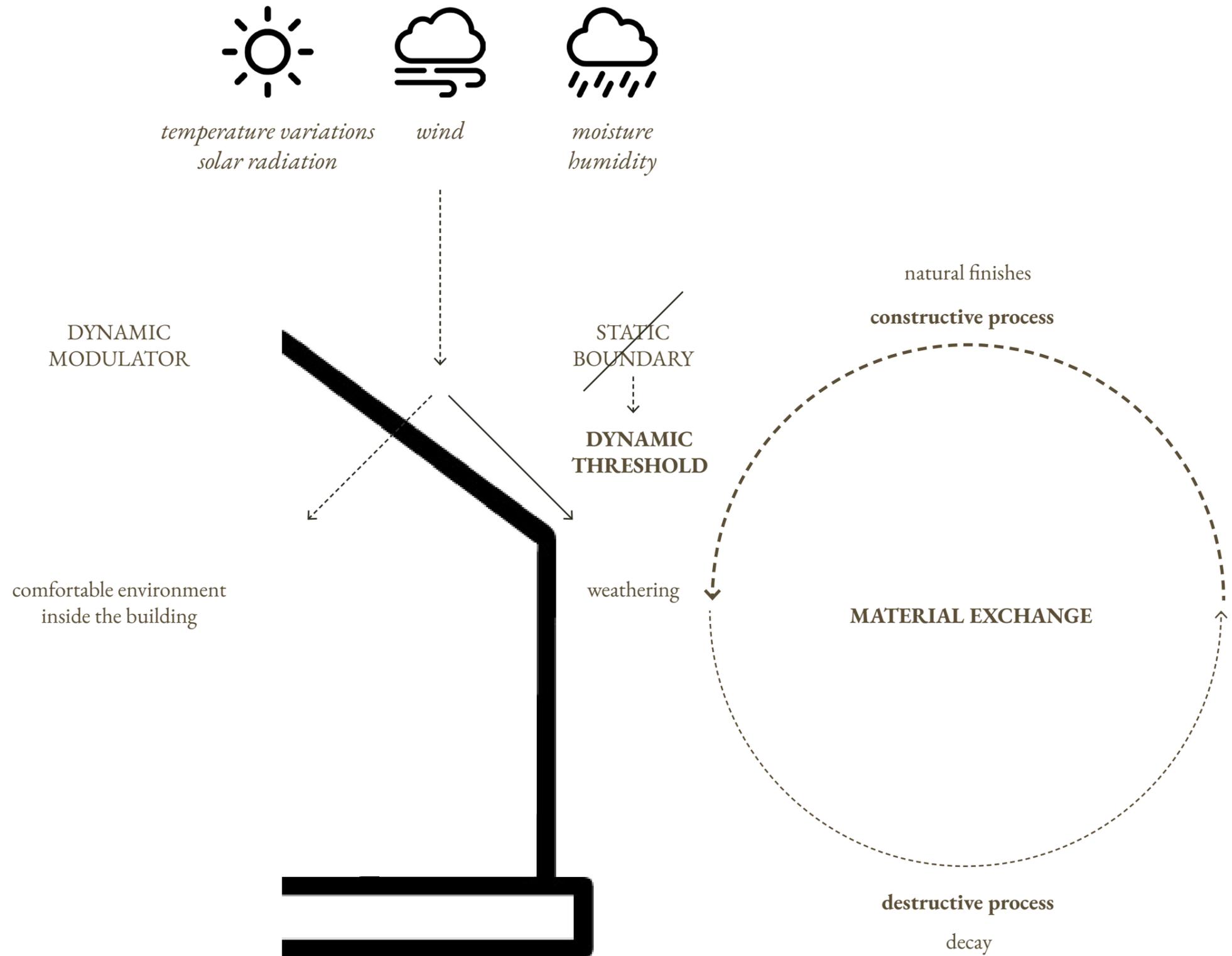
Building skin as a modulator vs. as a boundary



Building skin as a modulator vs. as a boundary



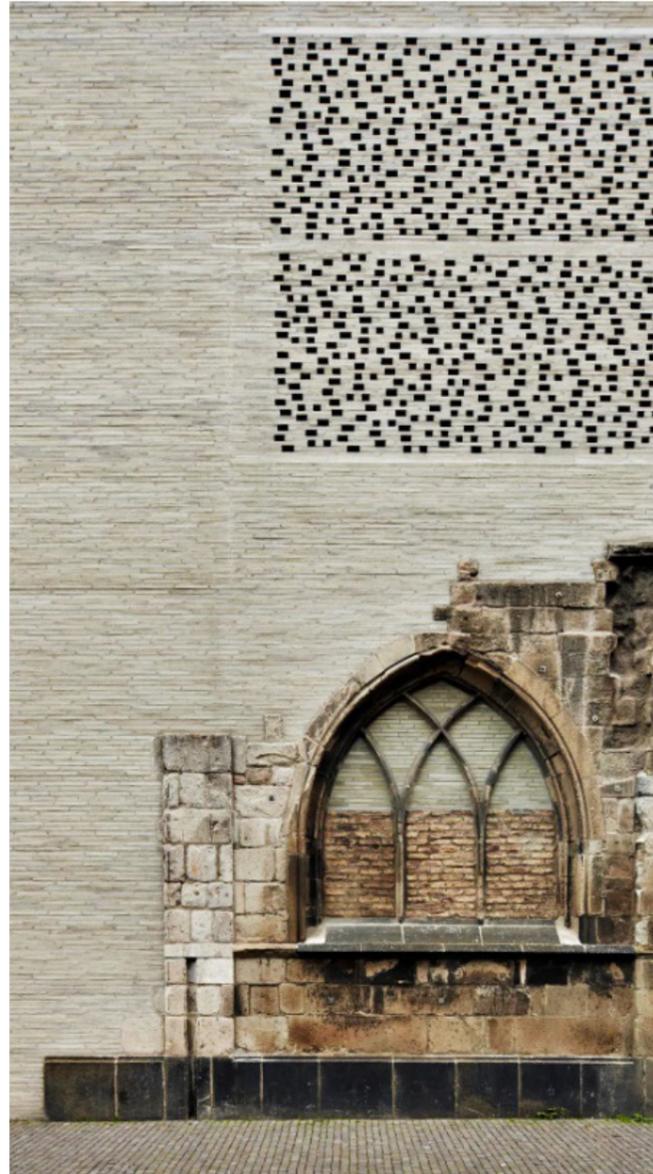
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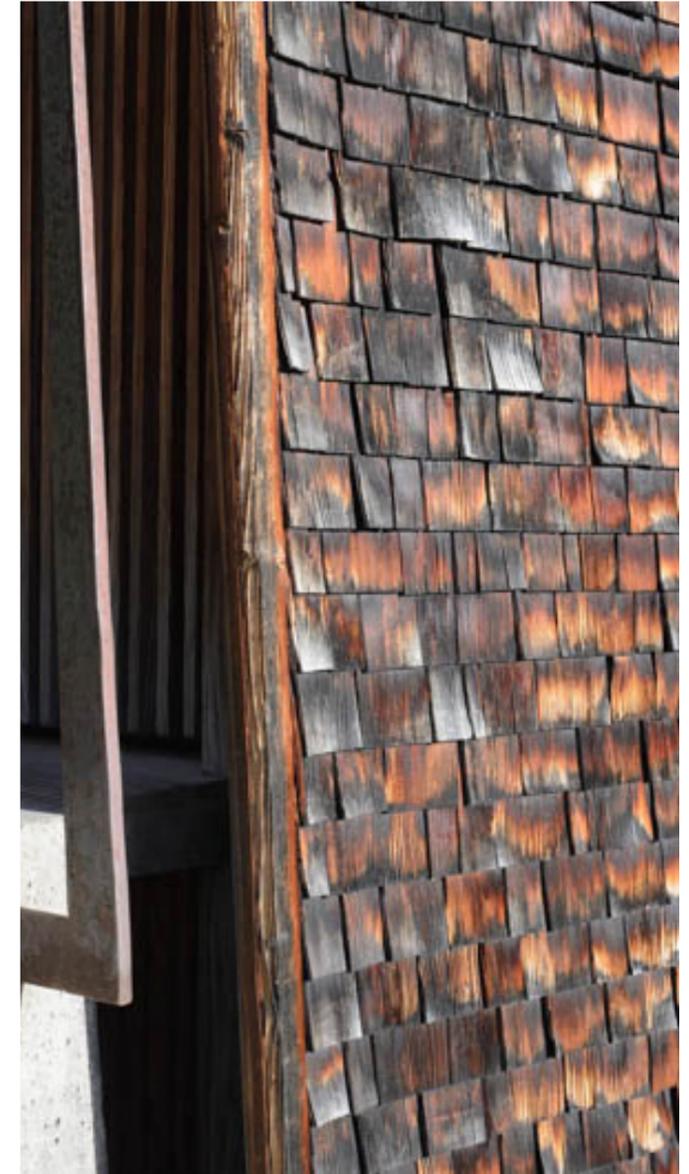
What if material weathering would not only be an acknowledged consequence...



CaixaForum / Herzog & de Meuron



Kolumba Museum / Peter Zumthor



Saint Benedict Chapel / Peter Zumthor

...but rather a key actor in the design process?

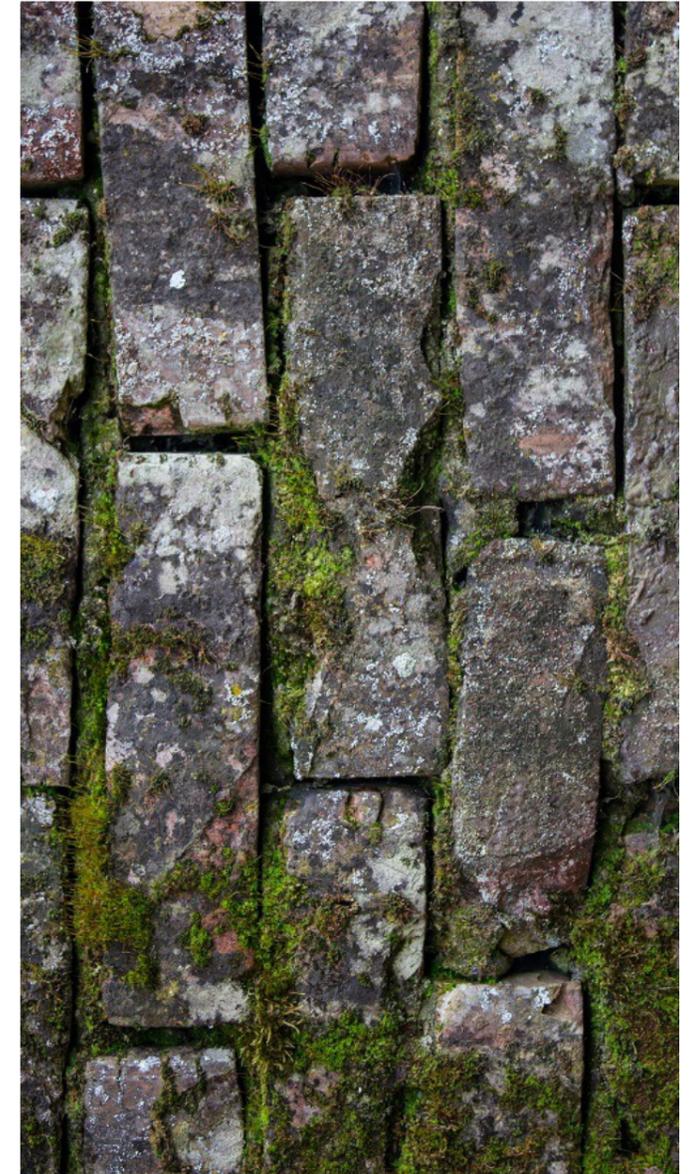
Weathering can have constructive outcomes only when the materials it impacts have protective mechanisms



Brion Cemetery / Carlo Scarpa



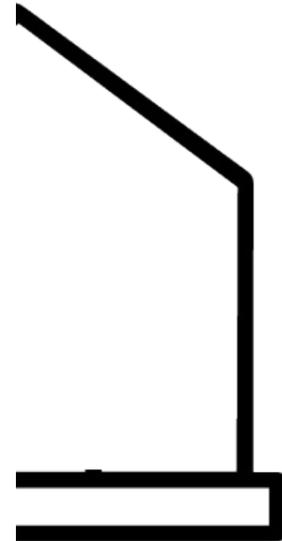
Casa Sabugo / Tagarro-De Miguel Arquitectos



moss growth on a brick facade

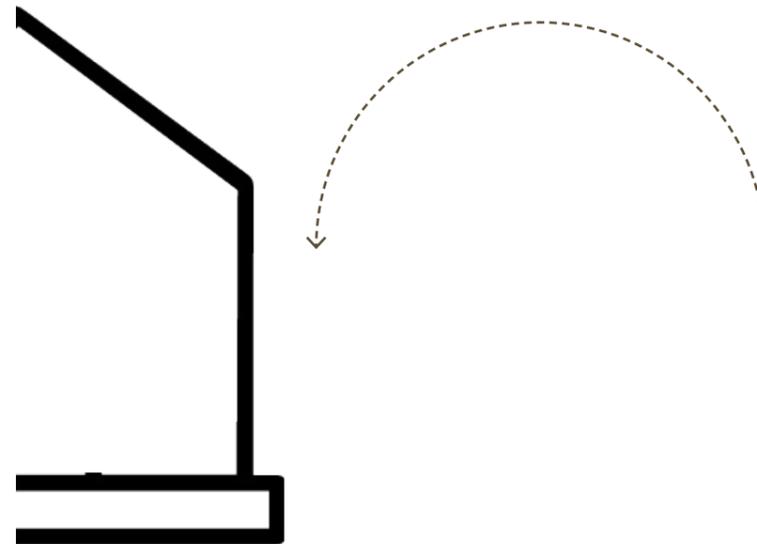
*How can **materials' protective mechanisms** be integrated with **design strategies** into a holistic design approach that **extends a building's lifespan** in a changing climate?*

Rethink the buildings' skin to become a dynamic layer.



Rethink the buildings' skin to become a dynamic layer.

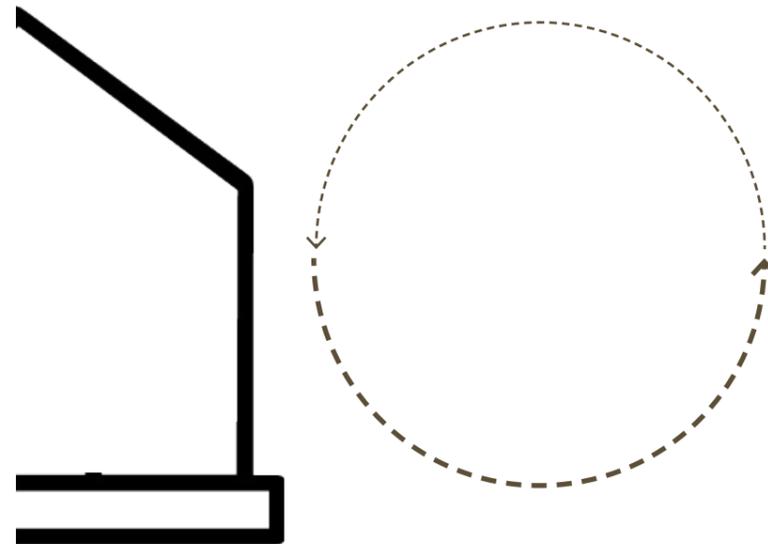
respond to the environment



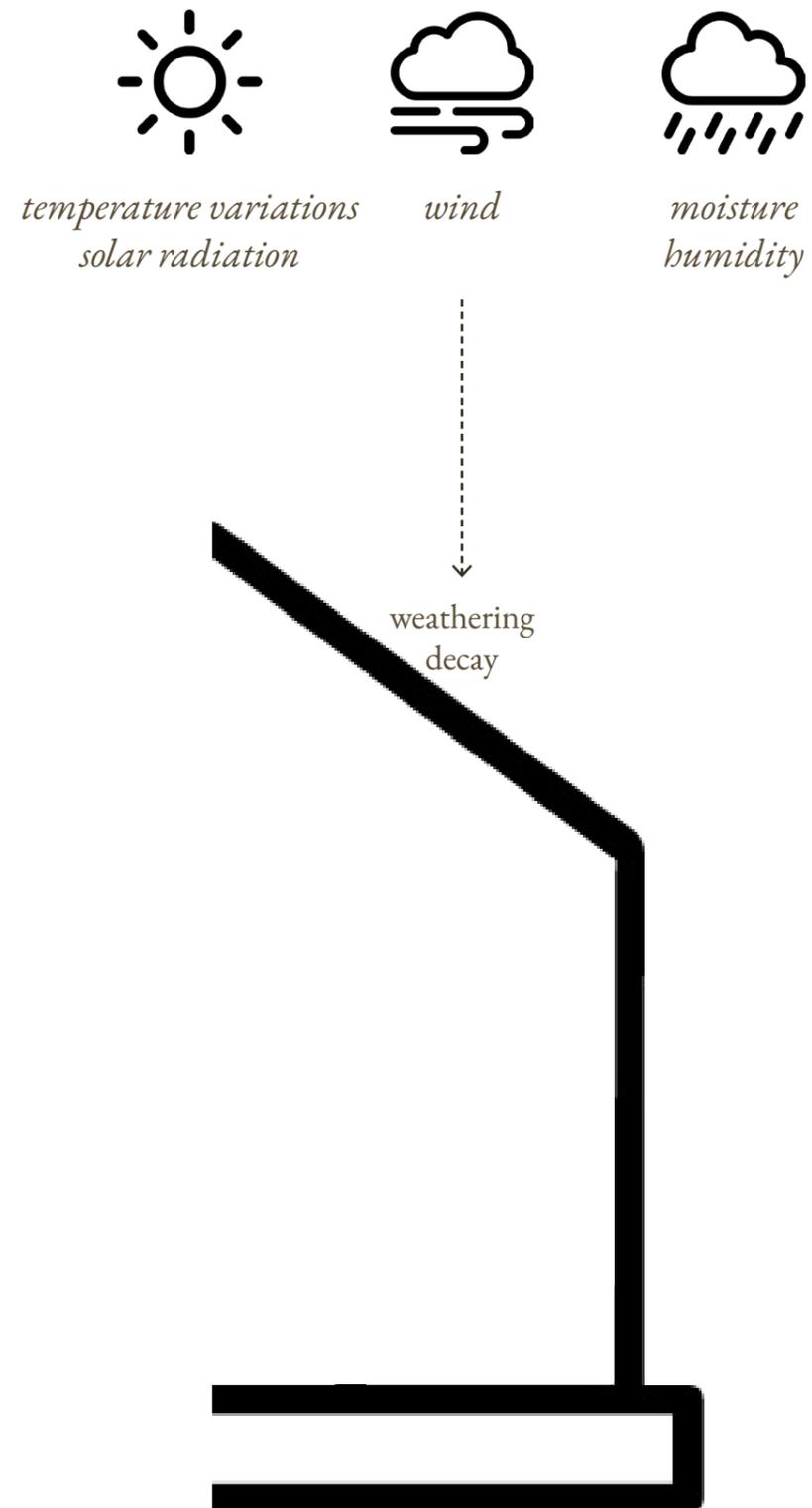
Rethink the buildings' skin to become a dynamic layer.

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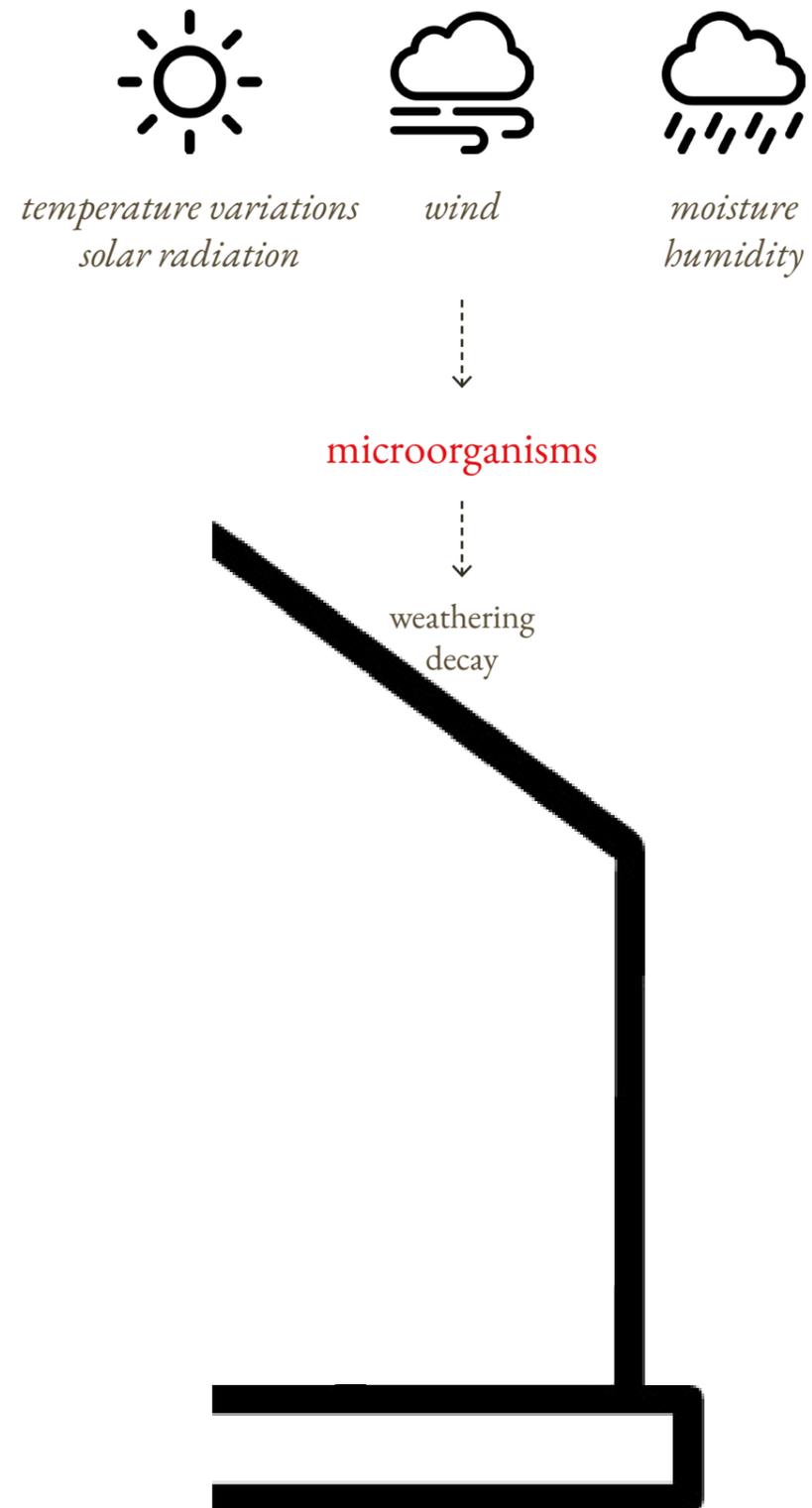
achieve a symbiotic relationship with it



Research findings



Research findings



Microorganisms and their constructive behaviour within the built environment

bioprotection



ivy layer falling off the wall / Reddit

bio-receptivity



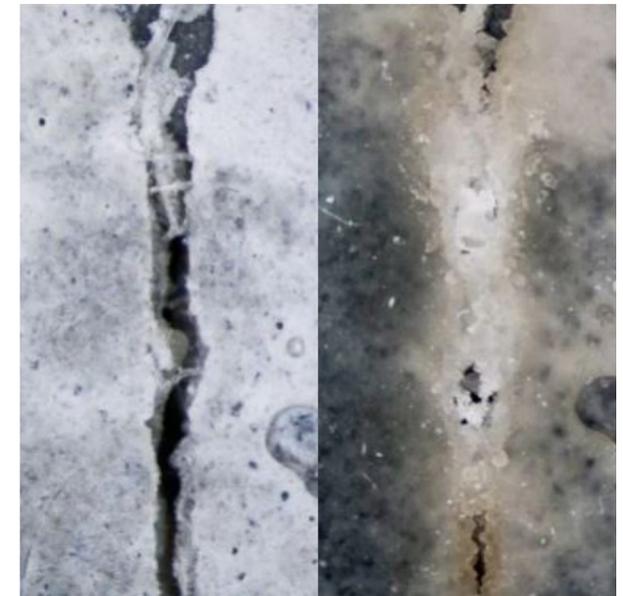
bioreceptive concrete / Respyre

self-growth



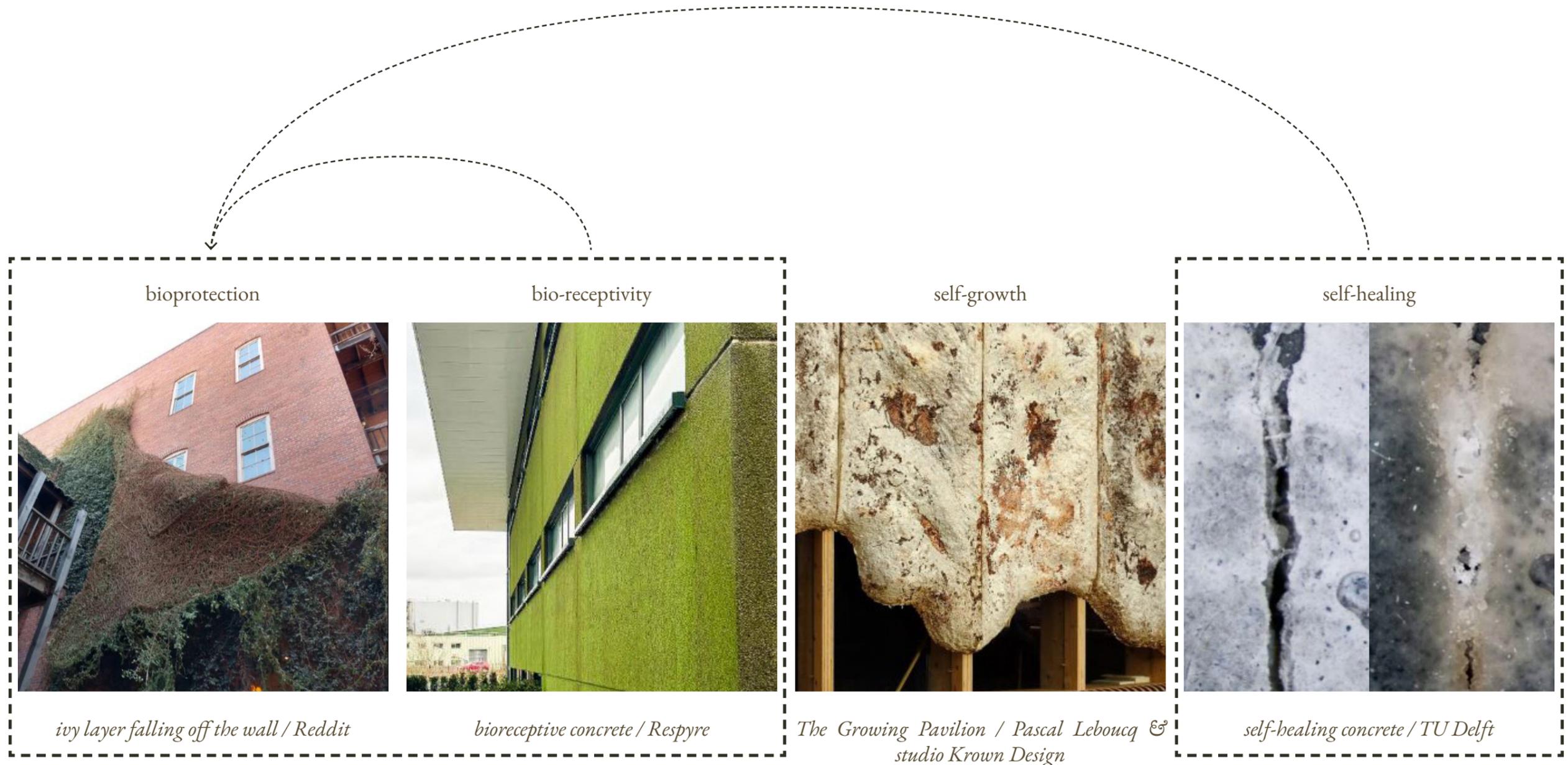
The Growing Pavilion / Pascal Leboucq & studio Krown Design

self-healing



self-healing concrete / TU Delft

Microorganisms and their constructive behaviour within the built environment



Microorganisms and their constructive behaviour within the built environment

BIOPROTECTION

PHYSICAL BIOPROTECTION

BIOMINERALIZATION

natural

all rock- and mineral-based materials are naturally bio-receptive



engineered

bio-receptive concrete, mortar, bricks



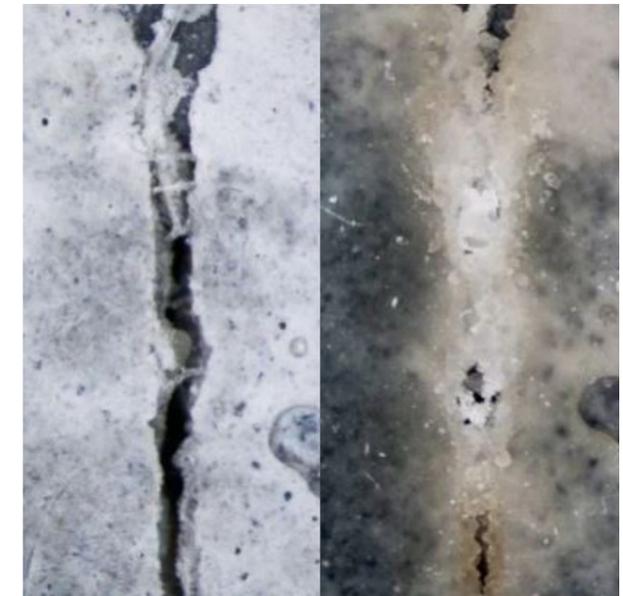
natural

specific lichens produce calcium carbonates and calcium oxalates



engineered

self-healing and engineered coatings



BIO-RECEPTIVITY

SELF-HEALING

Material selection and geometry summary

South & West elevations

North & East elevations

Materiality

Materiality

- bioreceptive concrete
- bioreceptive mortar

- ceramics
- bricks

- limestone
- sandstone

- ceramics
- bricks

Environmental conditions

- high solar radiation
- S-W prevailing winds lead to strong erosion, high rain exposure and rapid drying

Environmental conditions

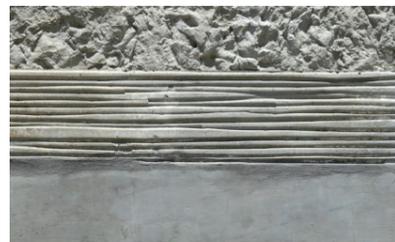
- minimal direct sunlight
- less wind, no drying, high moisture

Requirements

- no direct sunlight
- slow down water runoff

Requirements

- prevent water pooling



Material selection and geometry summary

South & West elevations

North & East elevations

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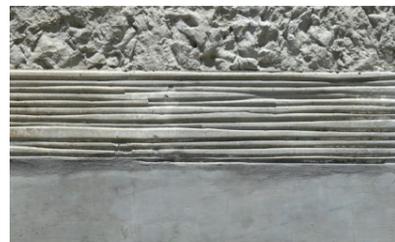
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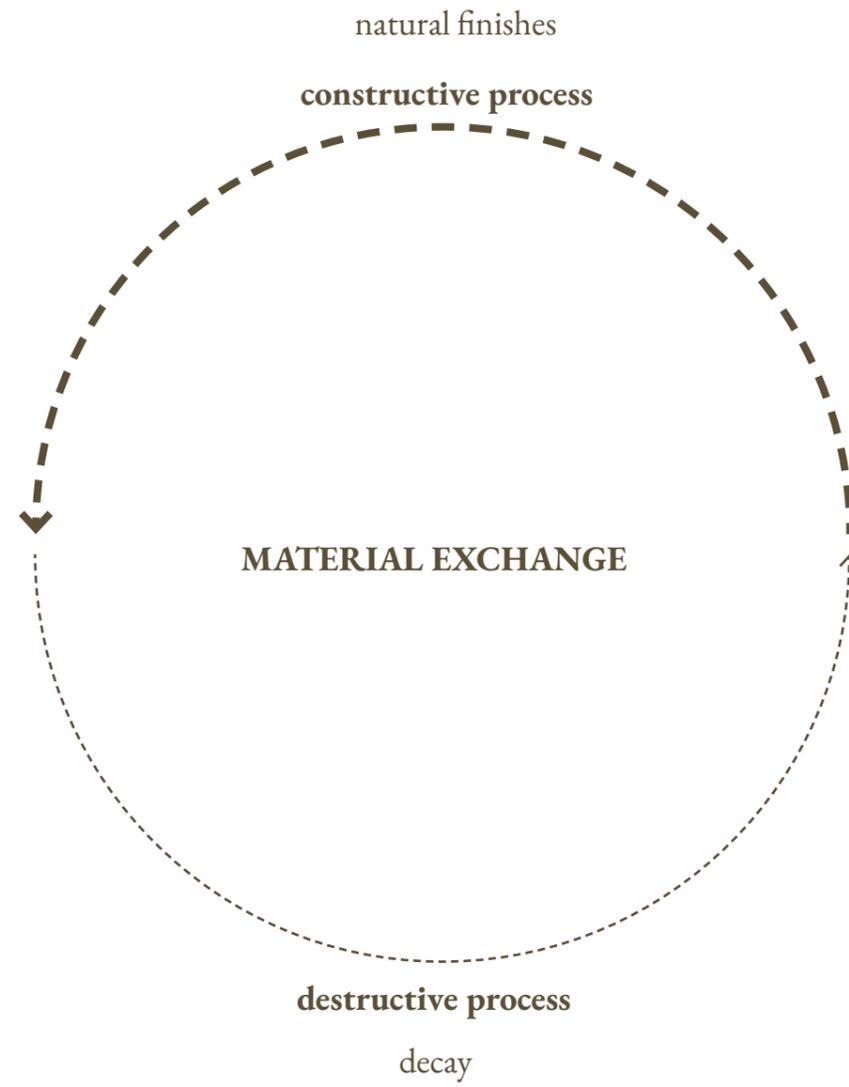
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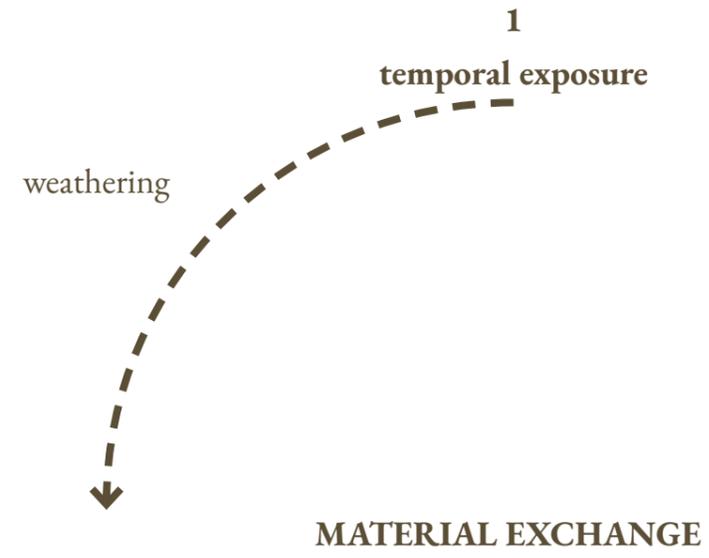
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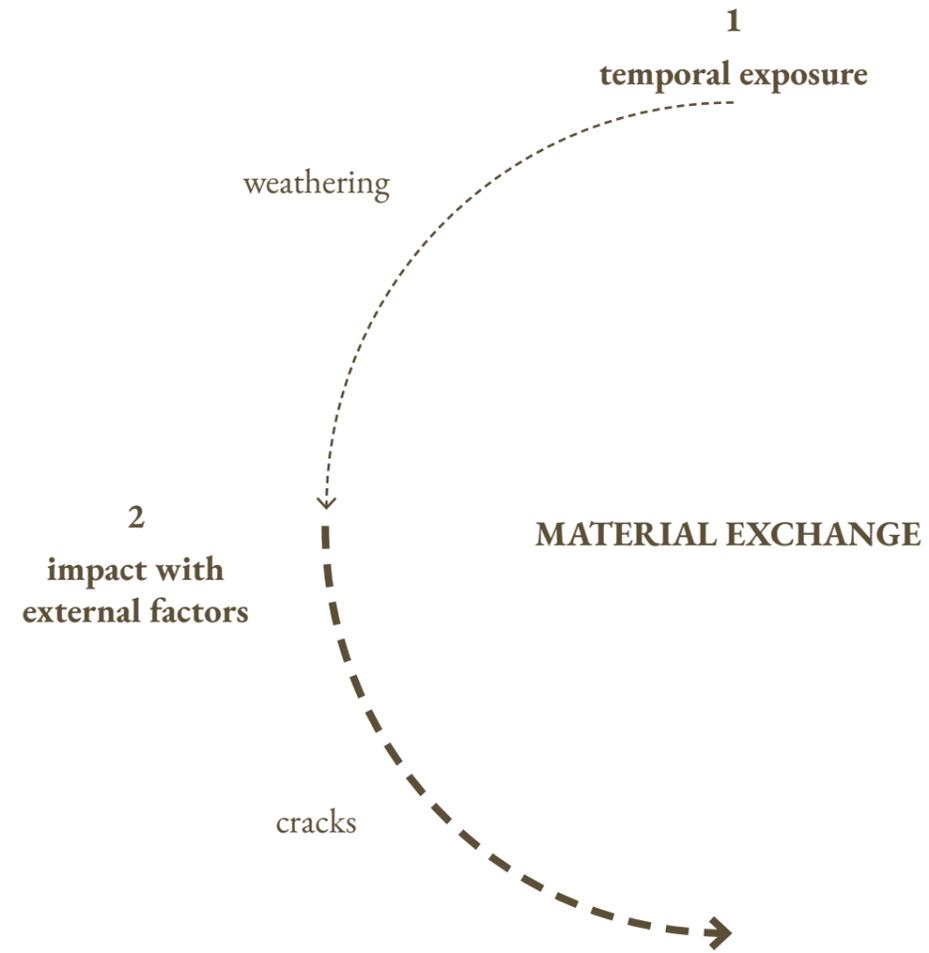


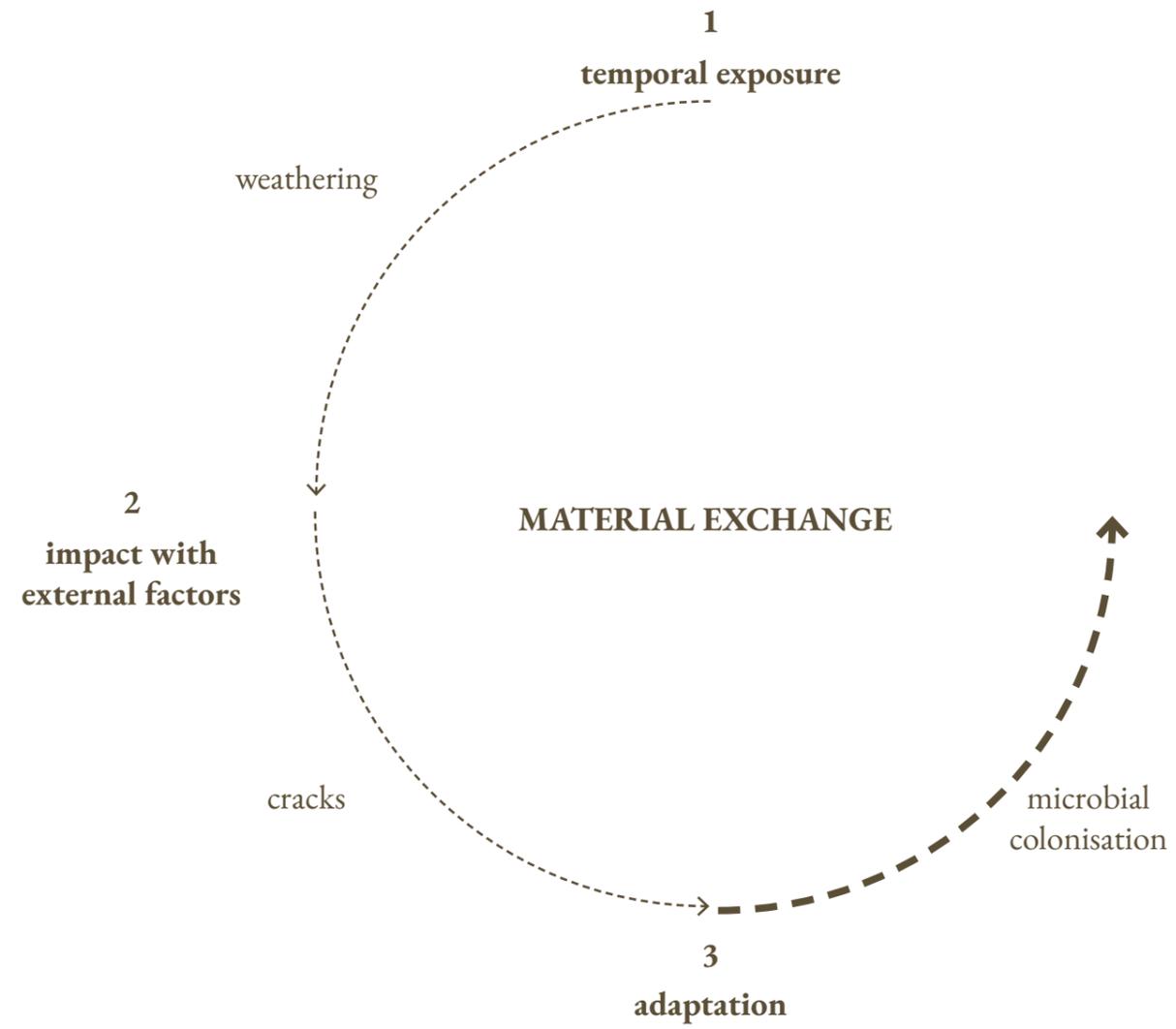
Conclusions:

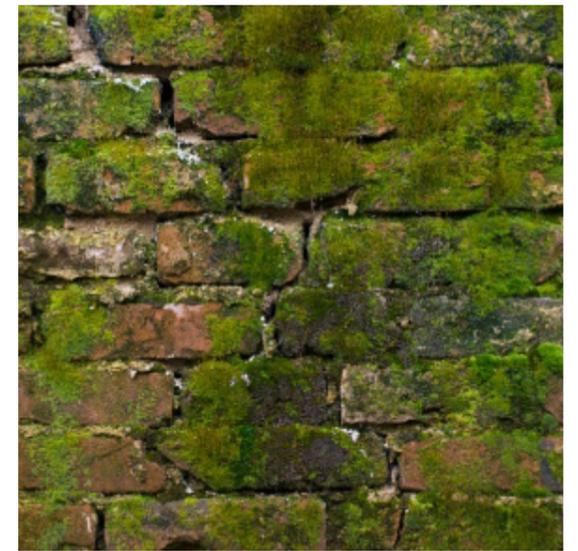
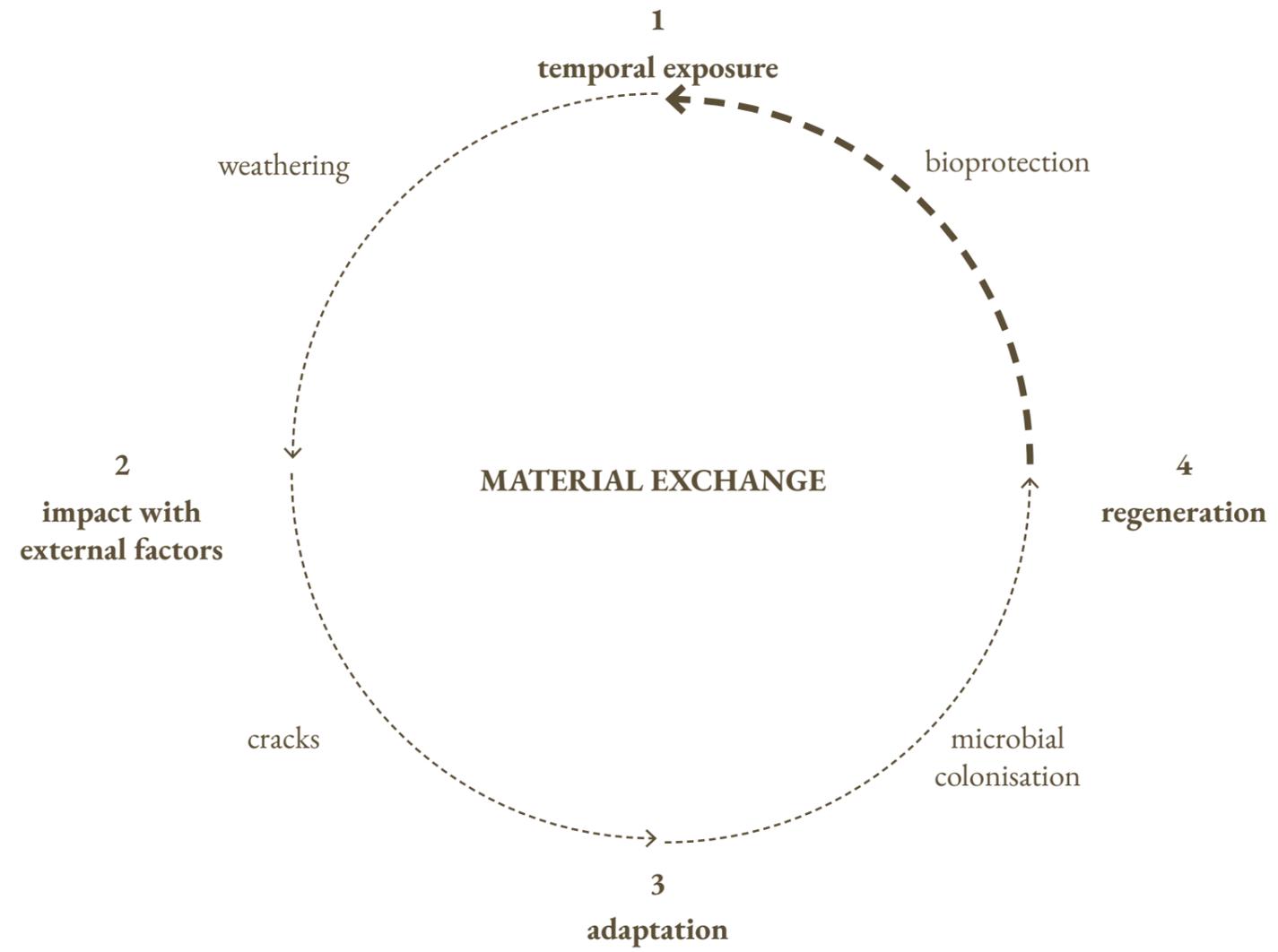
- control temperature while allowing for natural light
- manage rainwater flow on the elevation



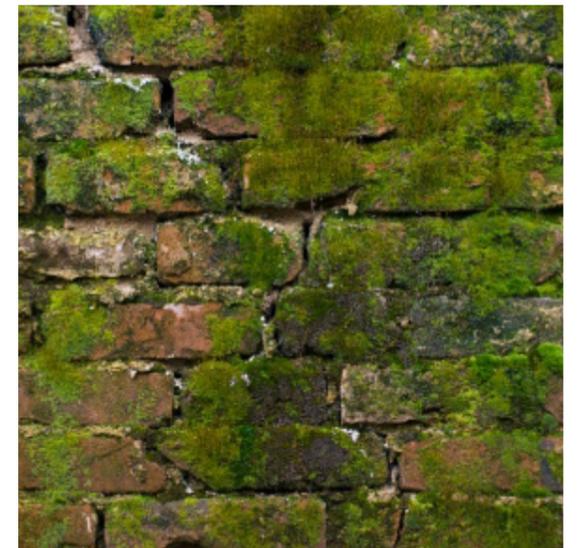
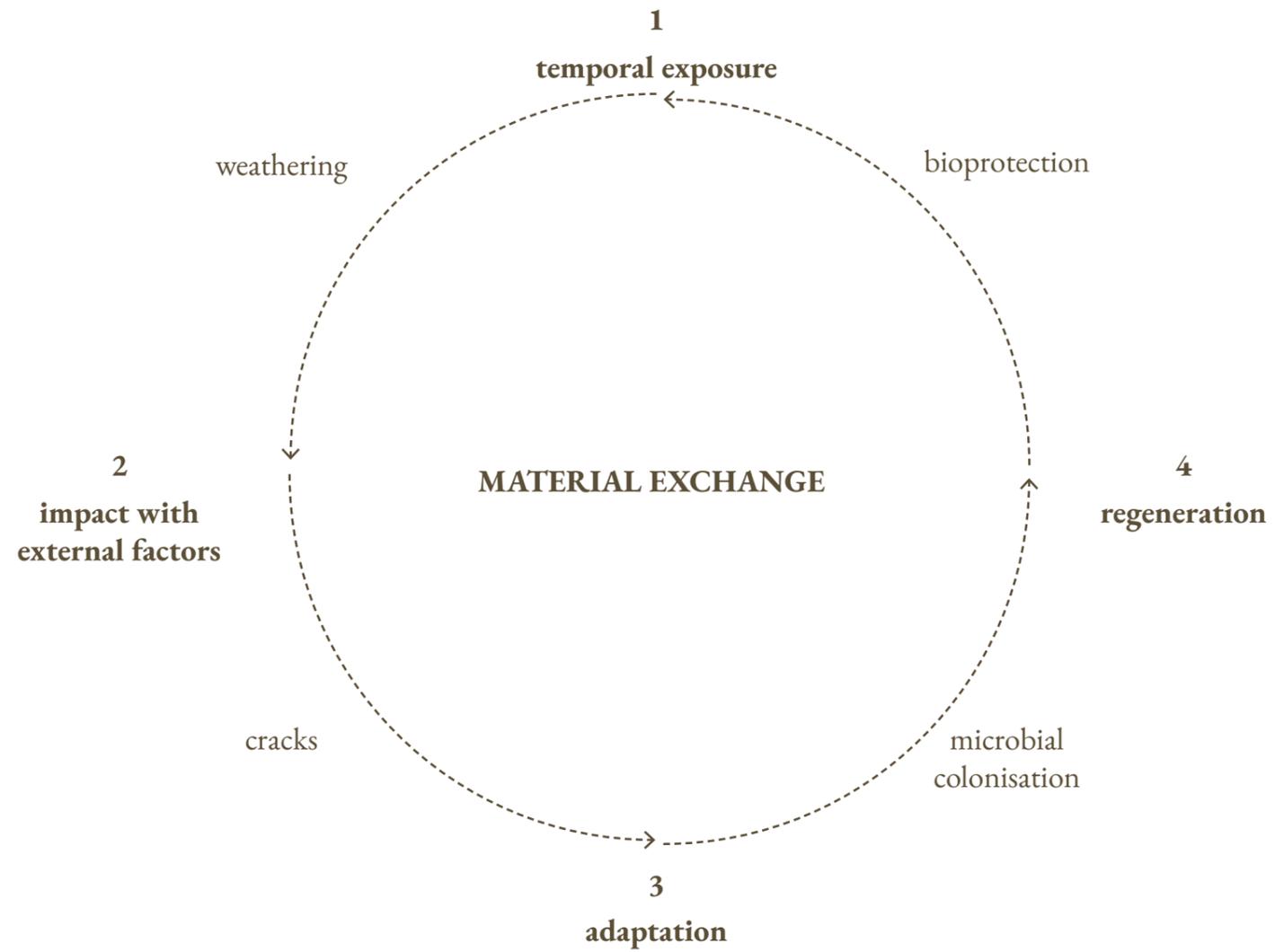








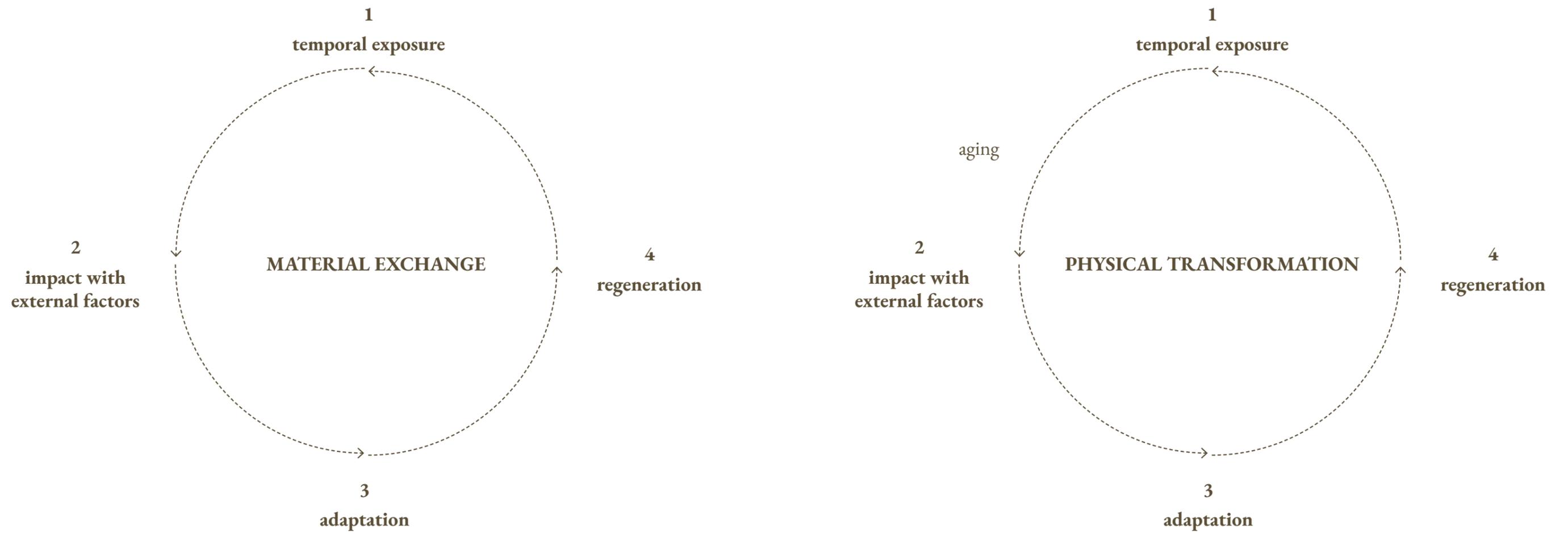
Weathering is a sign of resilience



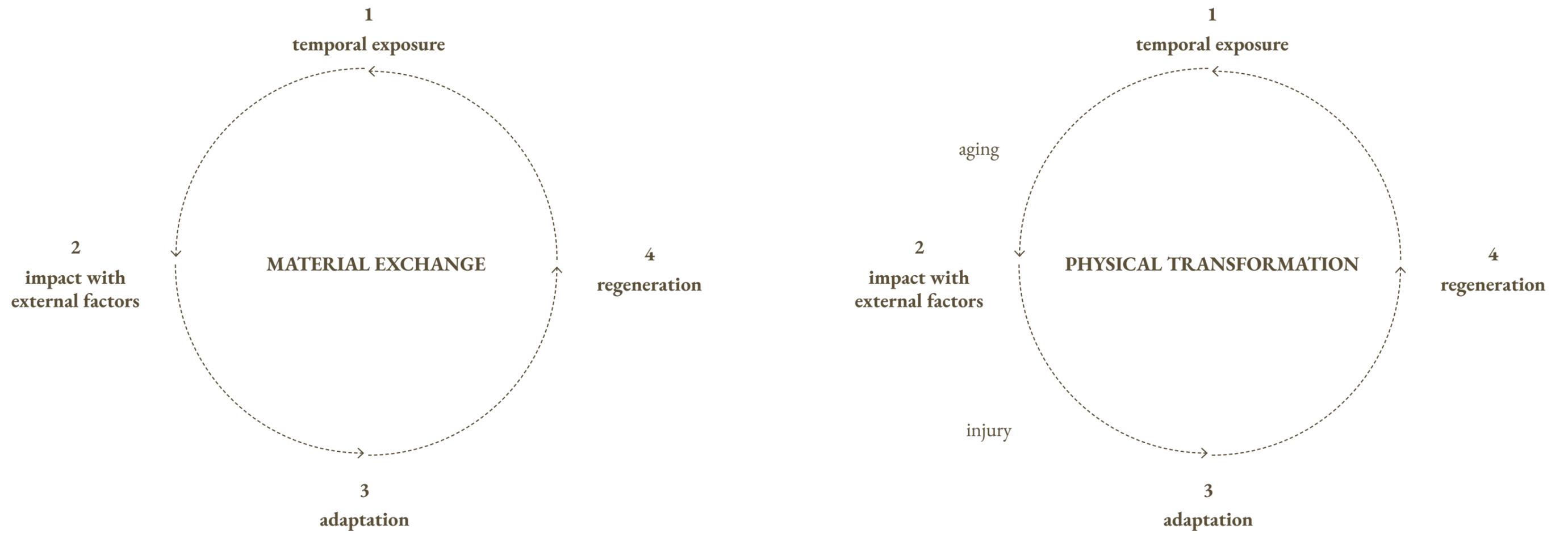
From material to physical resilience



From material to physical resilience



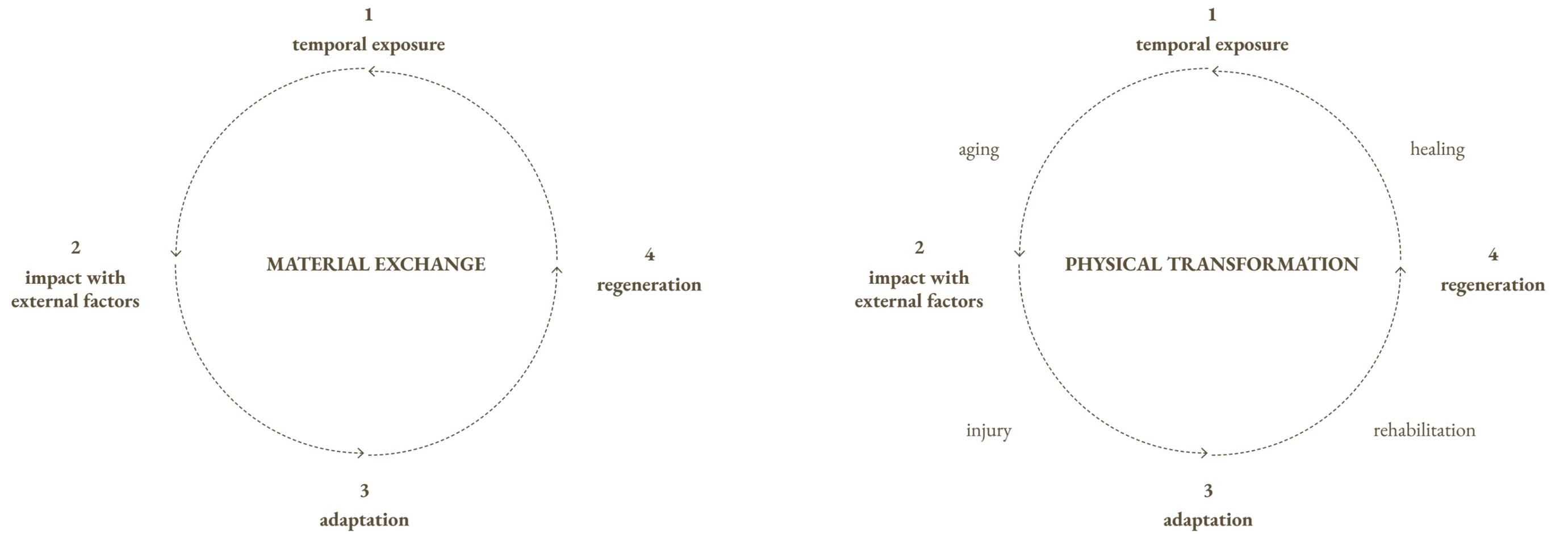
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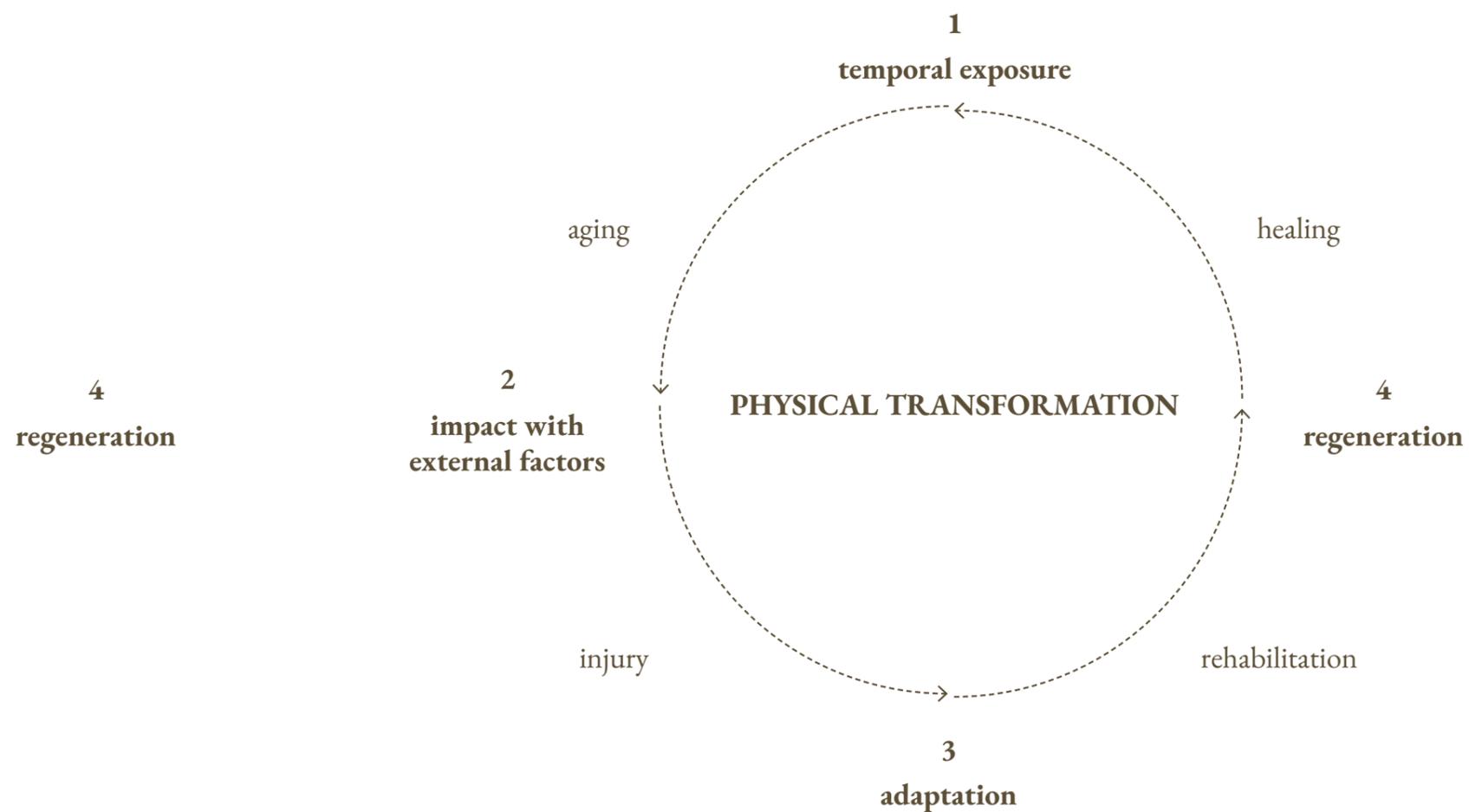
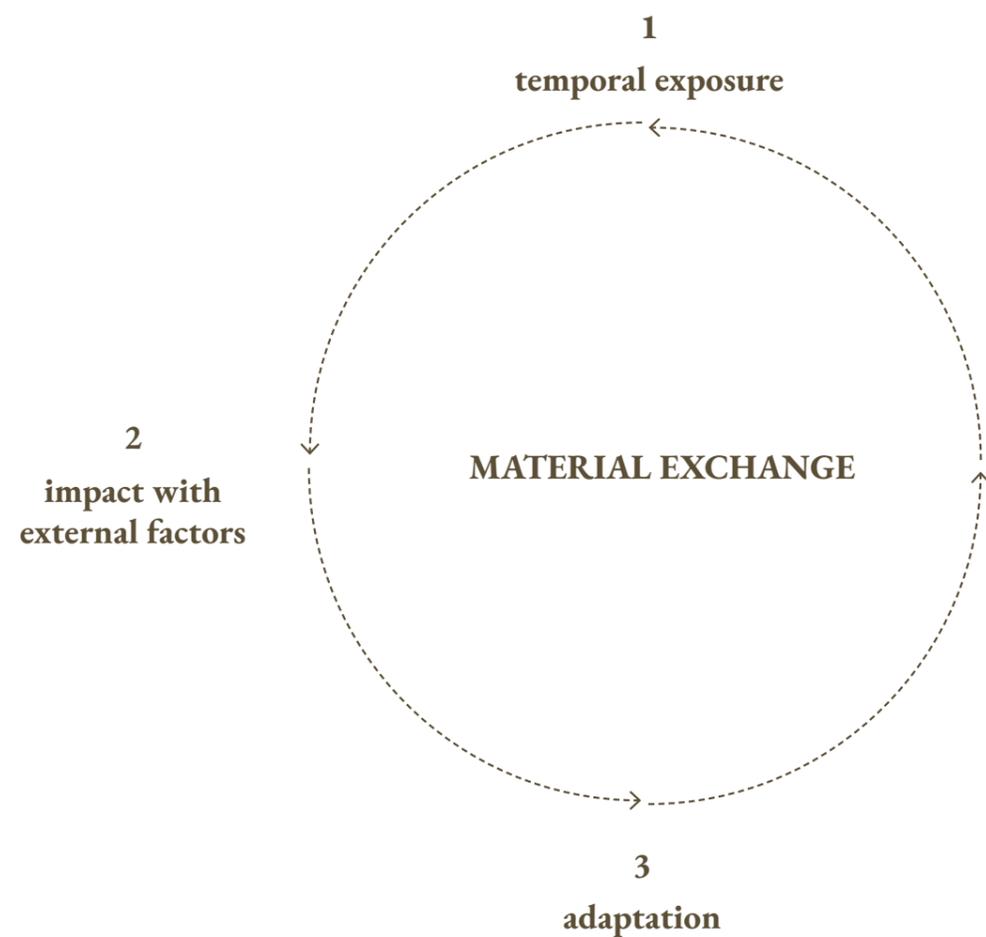
From material to physical resilience



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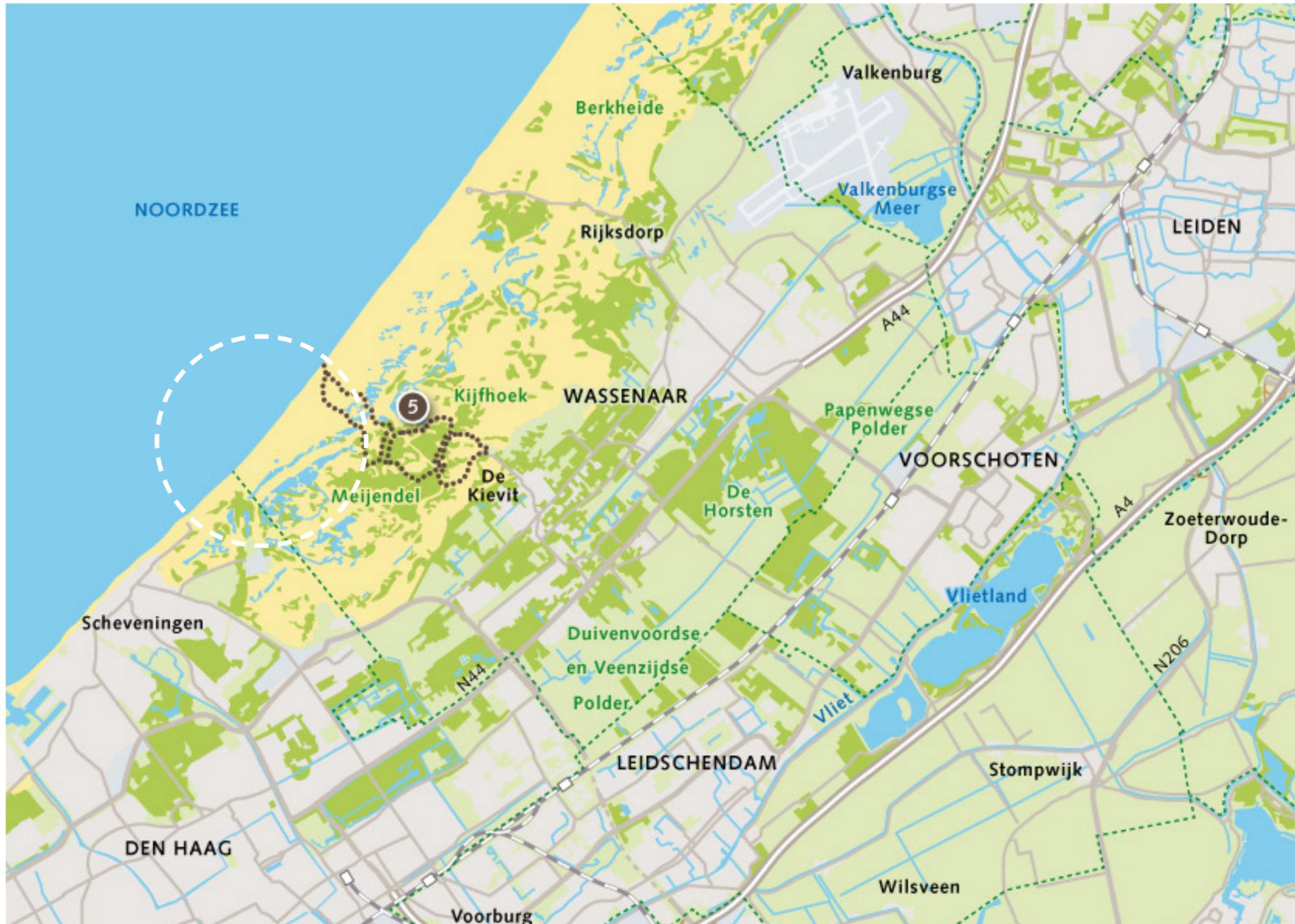
From material to physical resilience



Physical rehabilitation centre for athletes

Meijndel

Meijndel is the largest contiguous dune area in South Holland.



Meijendel

Traces of the Atlantic Wall



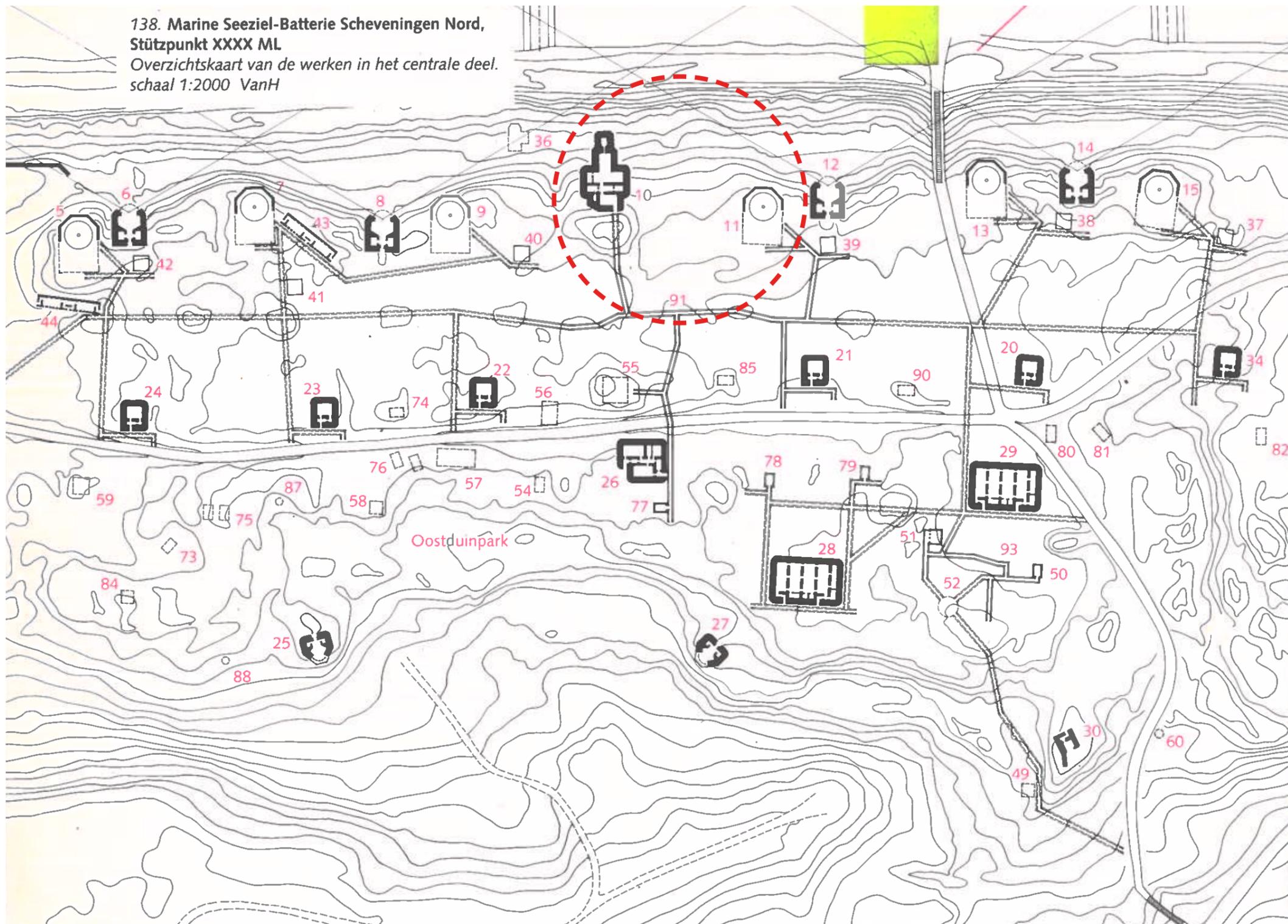
Meijendel

Sea targetting battery in Scheveningen Noord - S414 fire control post



Meijendel

Sea targeting battery in Scheveningen Noord - S414 fire control post



Meijendel

South-West view towards The Hague



Meijendel

Noth-East view



Meijendel

A place where materials are degrading at an accelerated pace

coastal area - extreme weather events



urban centre proximity - pollution



Meijendel

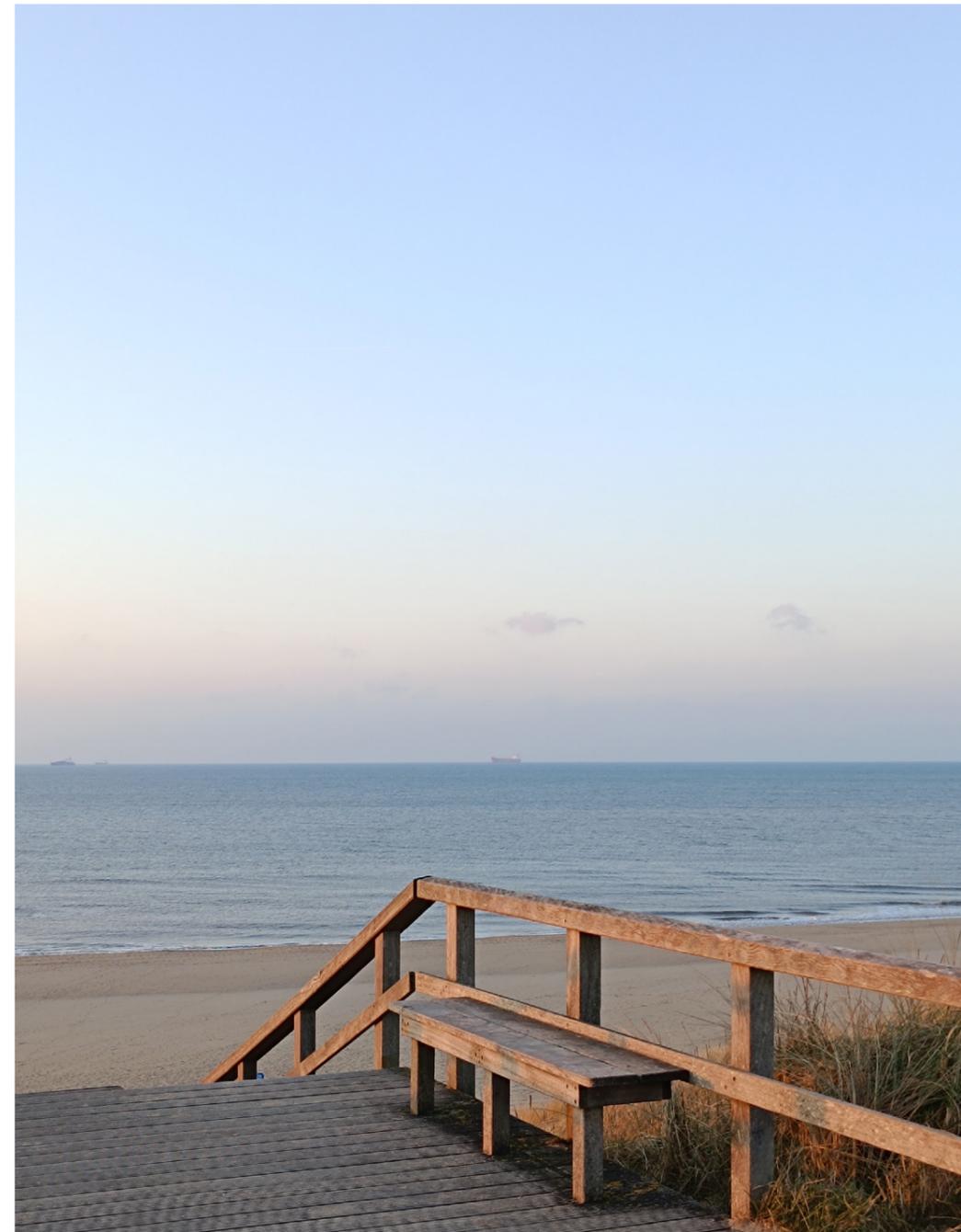
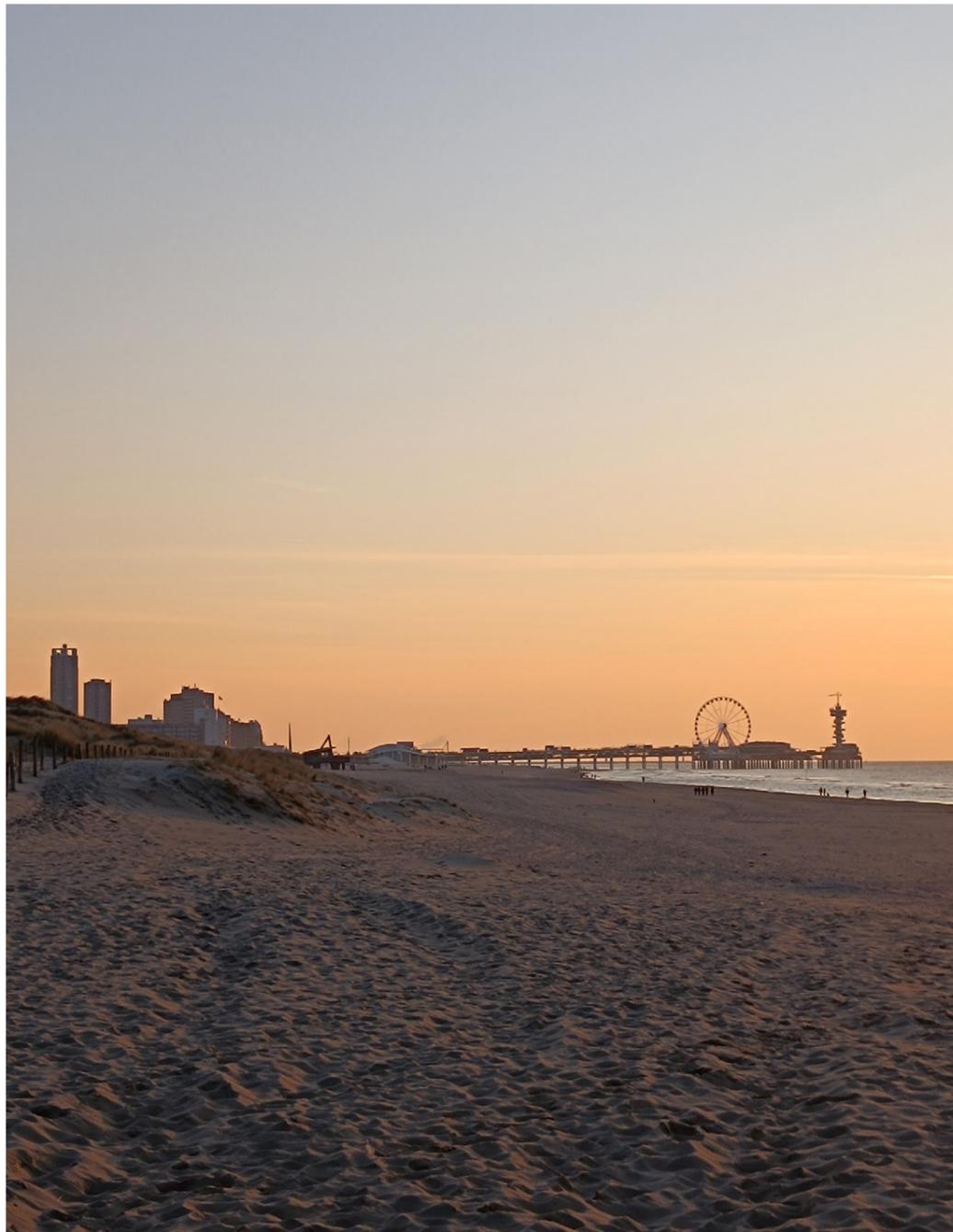
Ideal setting for a healing centre

peaceful, quiet environment

scenic views

clean, fresh air

outdoor exercise



Meijendel

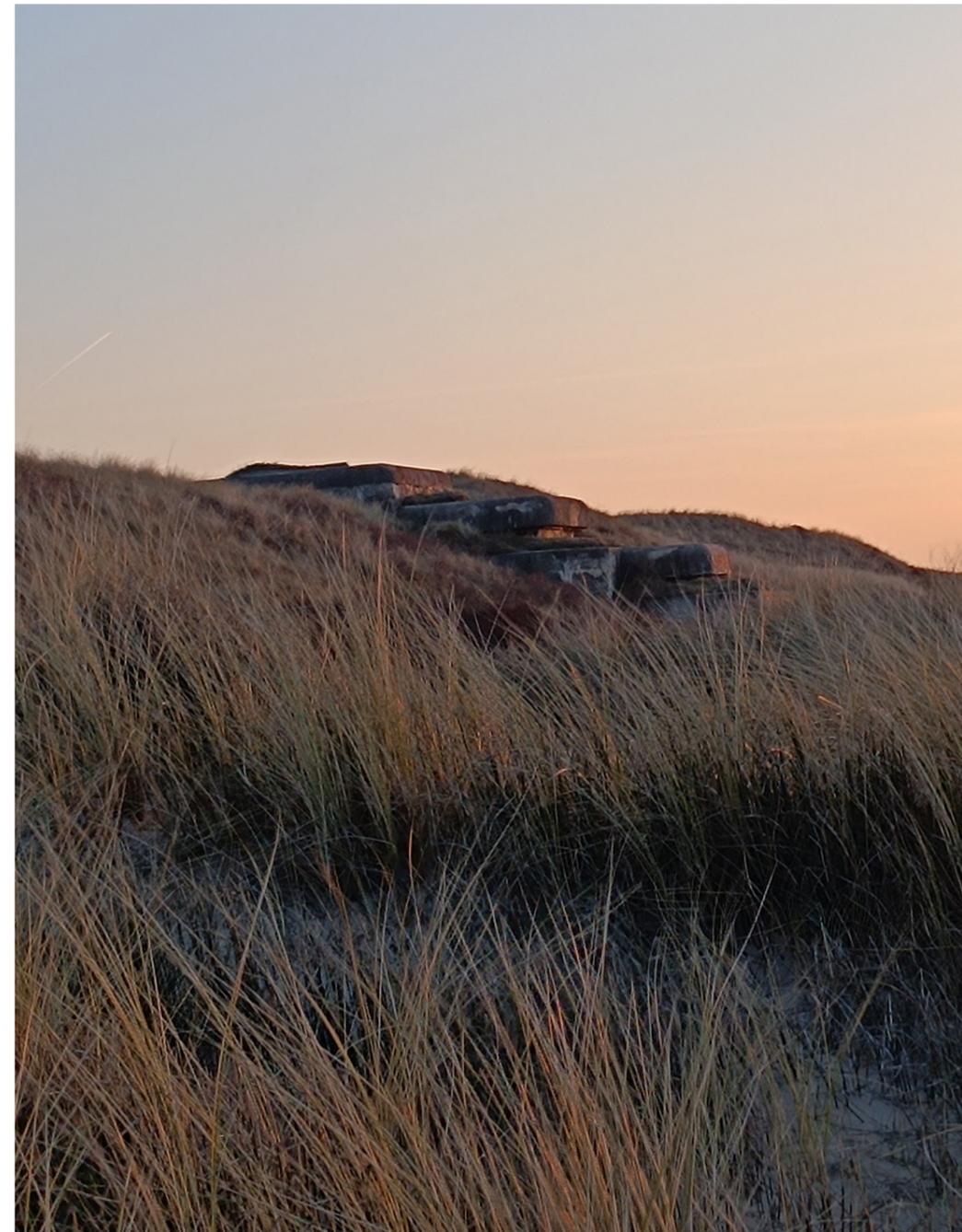
Rewriting the narrative and future of the bunker

unsettling feeling

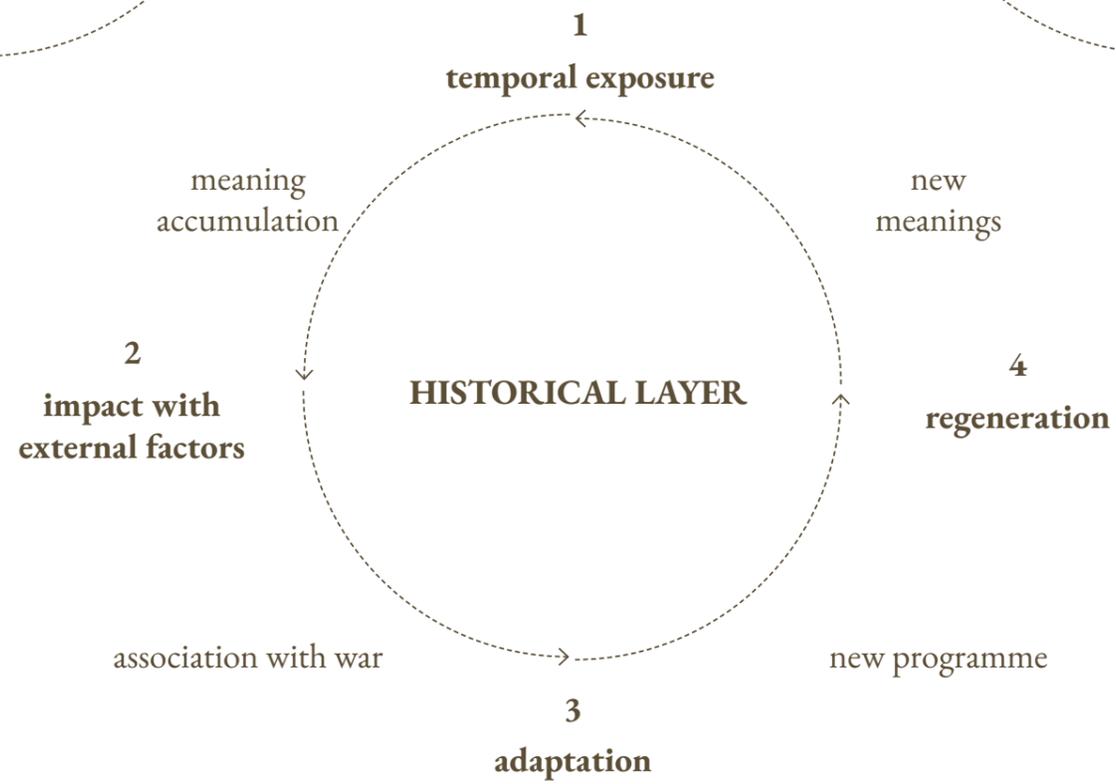
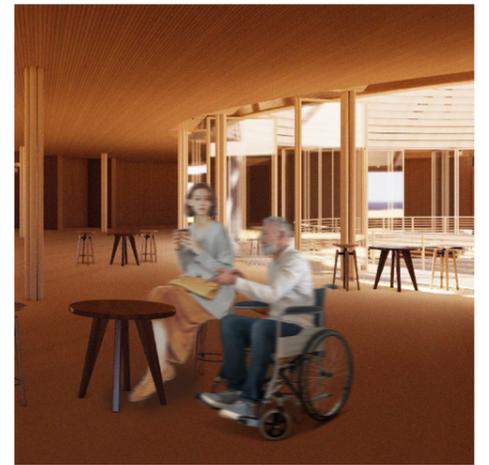
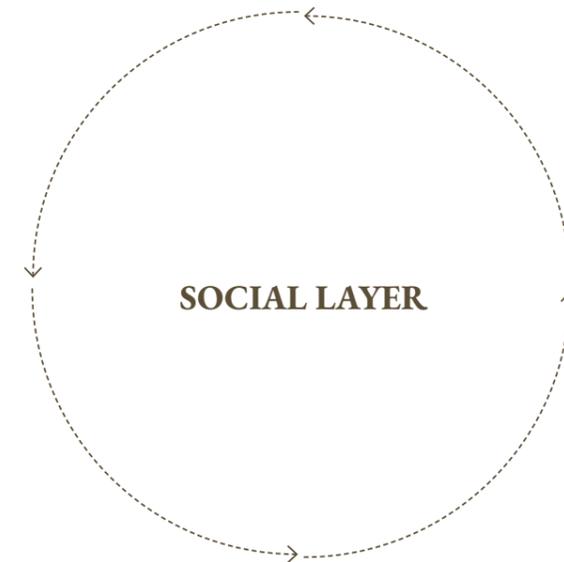
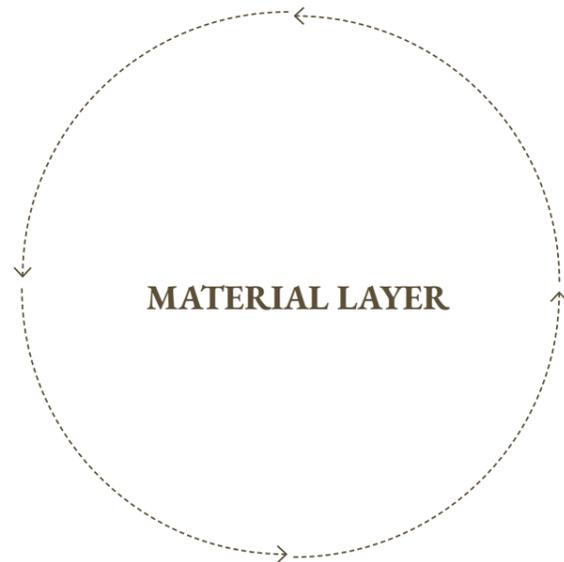
calming, comforting

abandoned

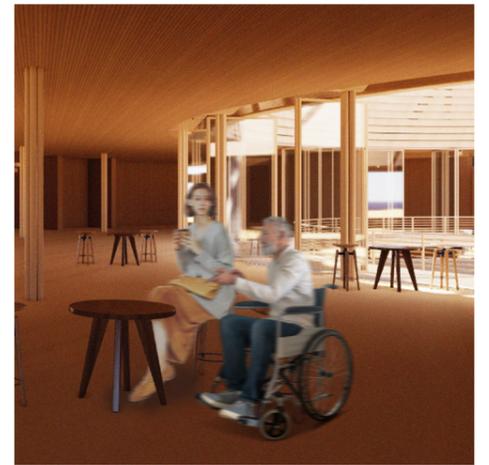
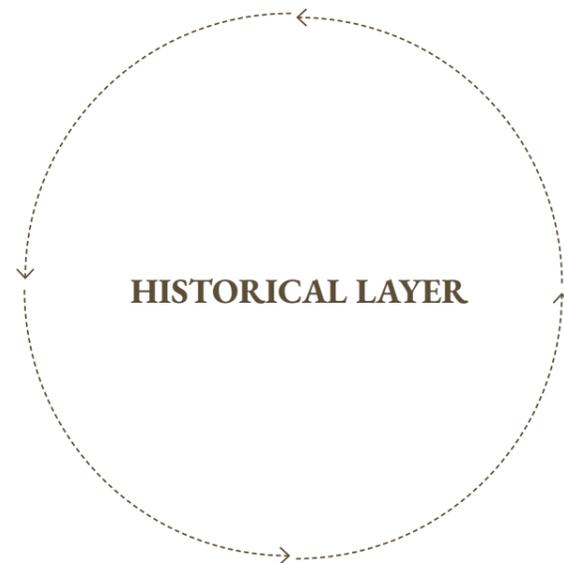
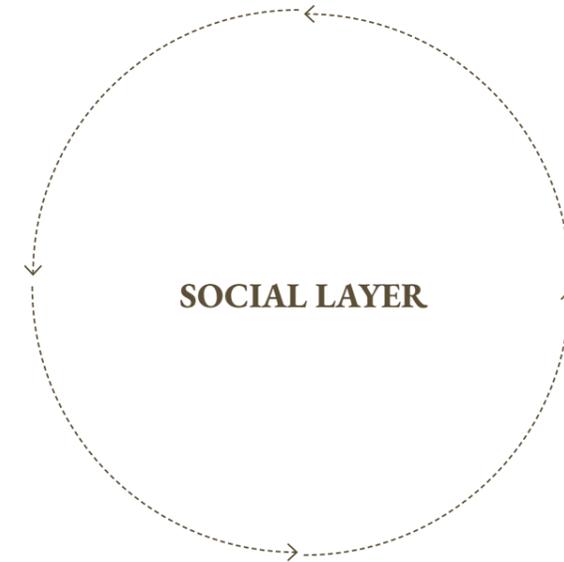
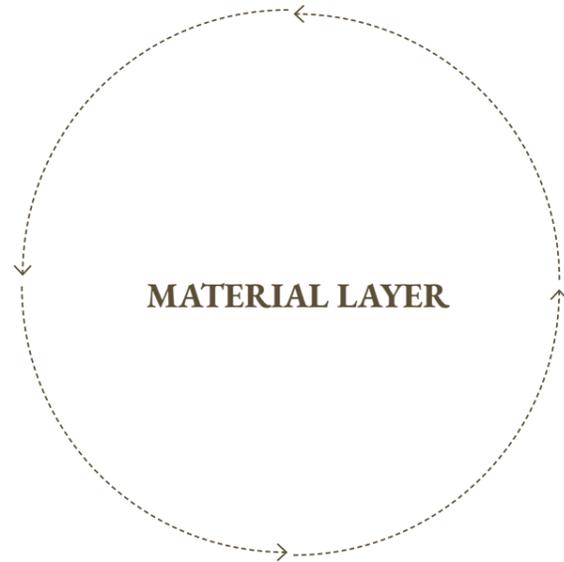
unlocking new opportunities



Layers of resilience

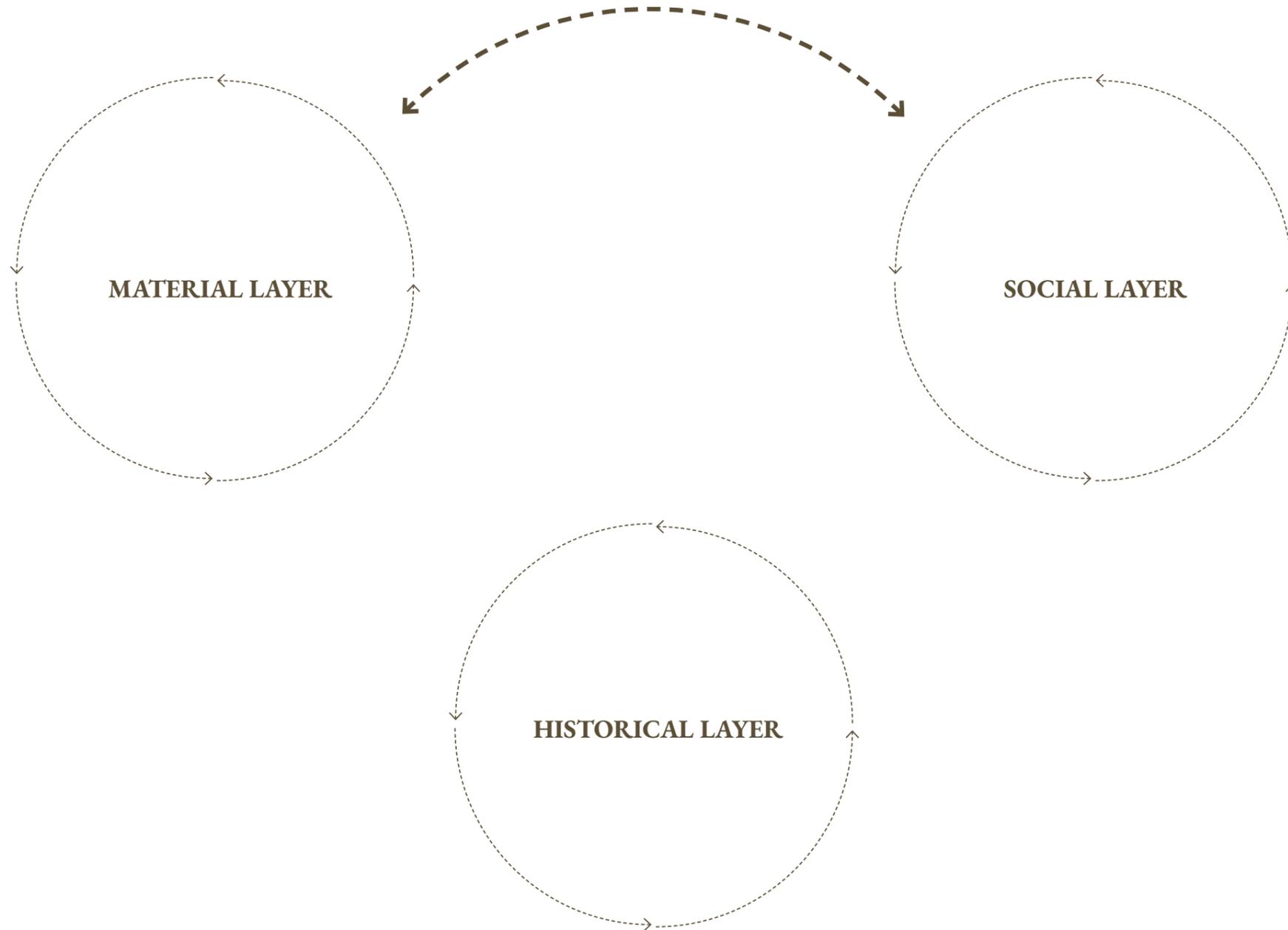


Layers of resilience



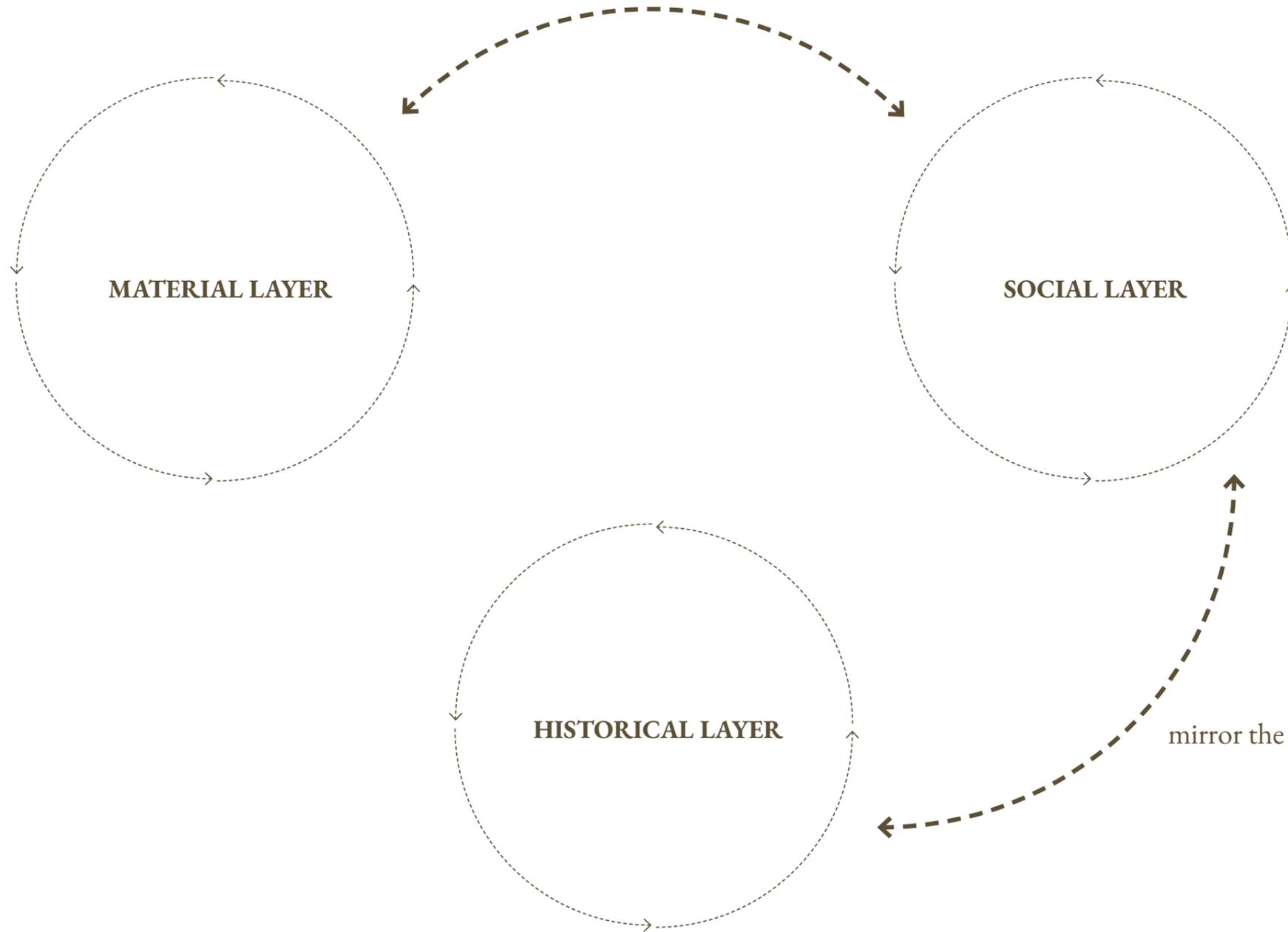
Layers of resilience

mirror the physical resilience



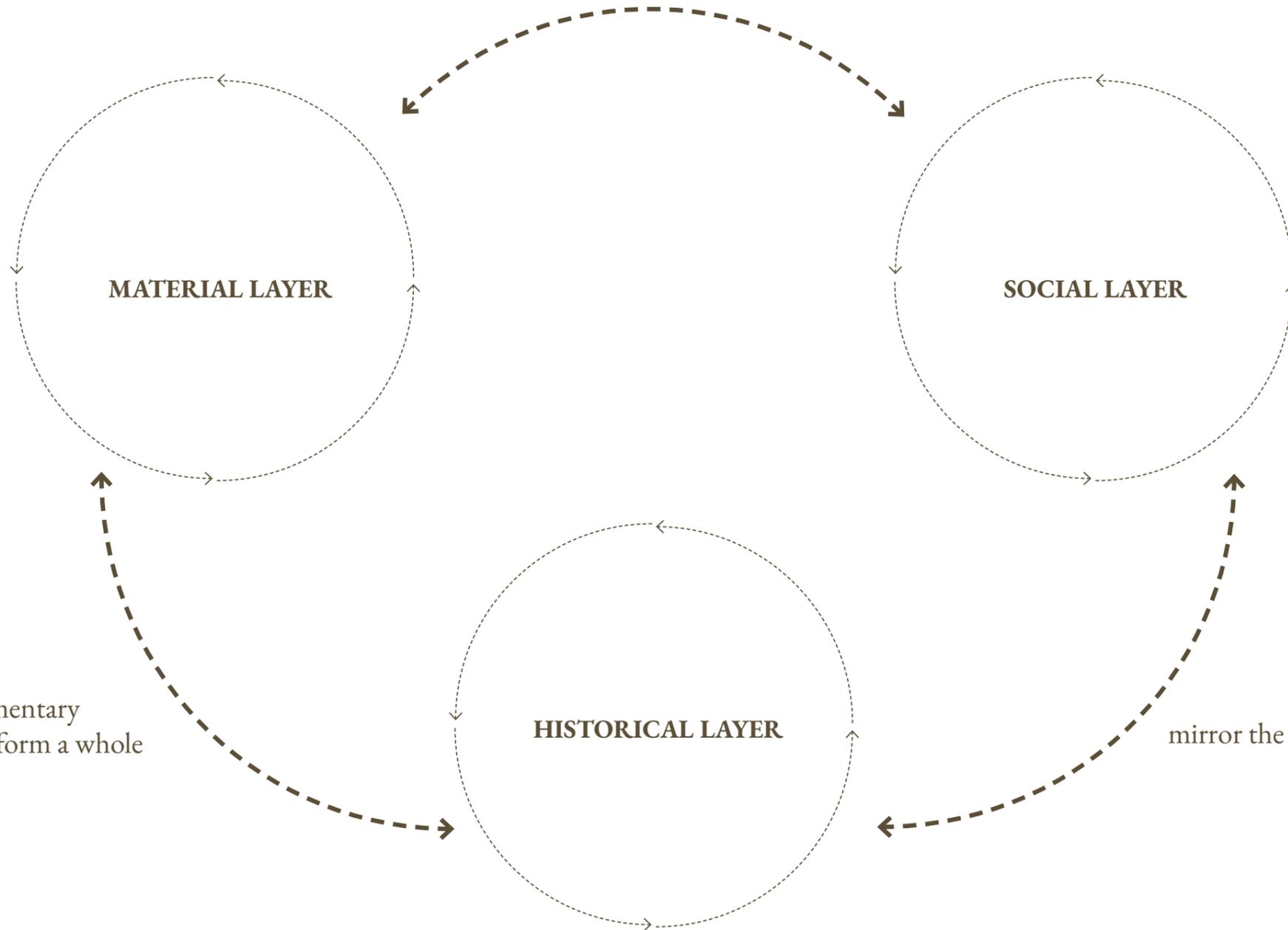
Layers of resilience

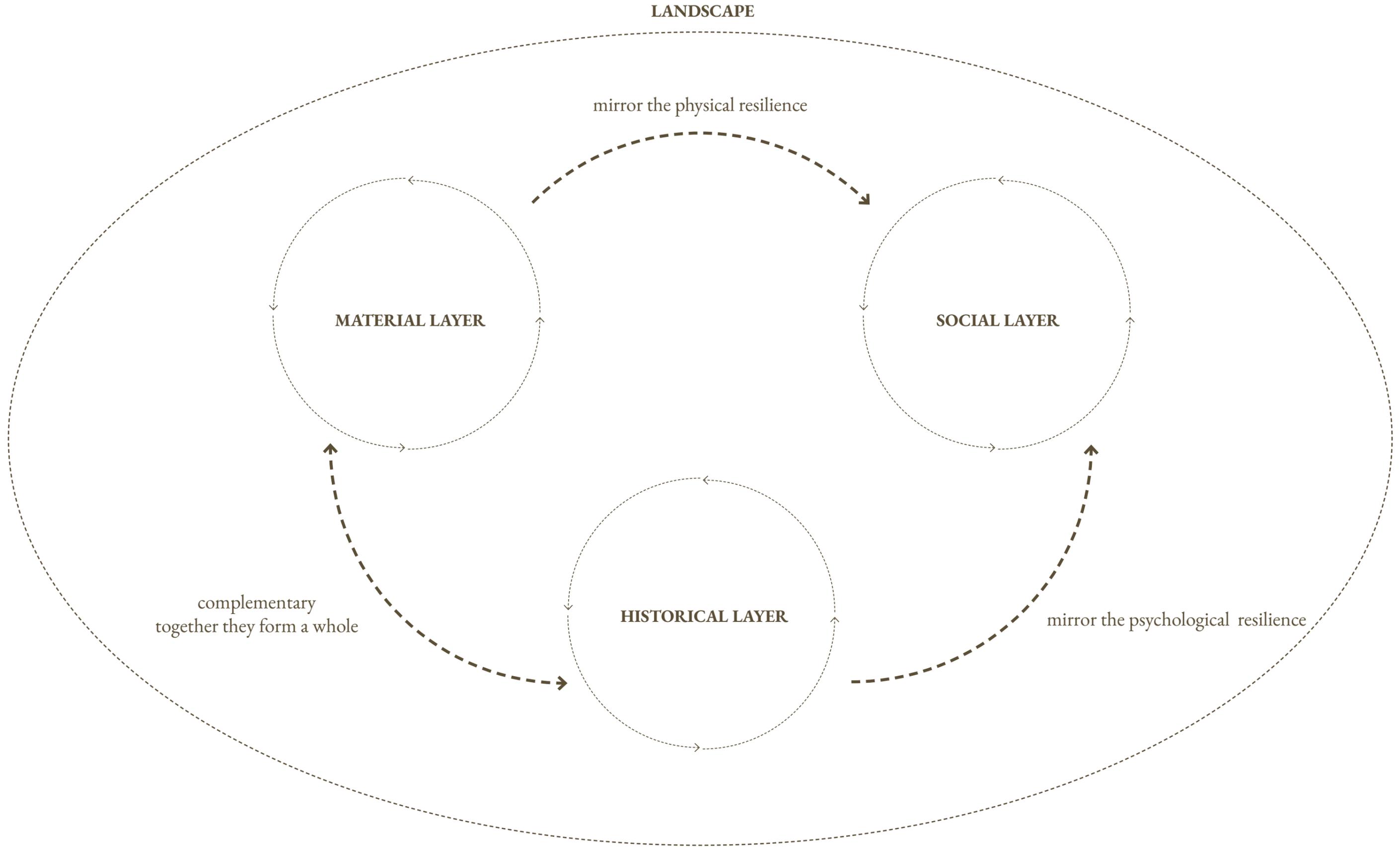
mirror the physical resilience

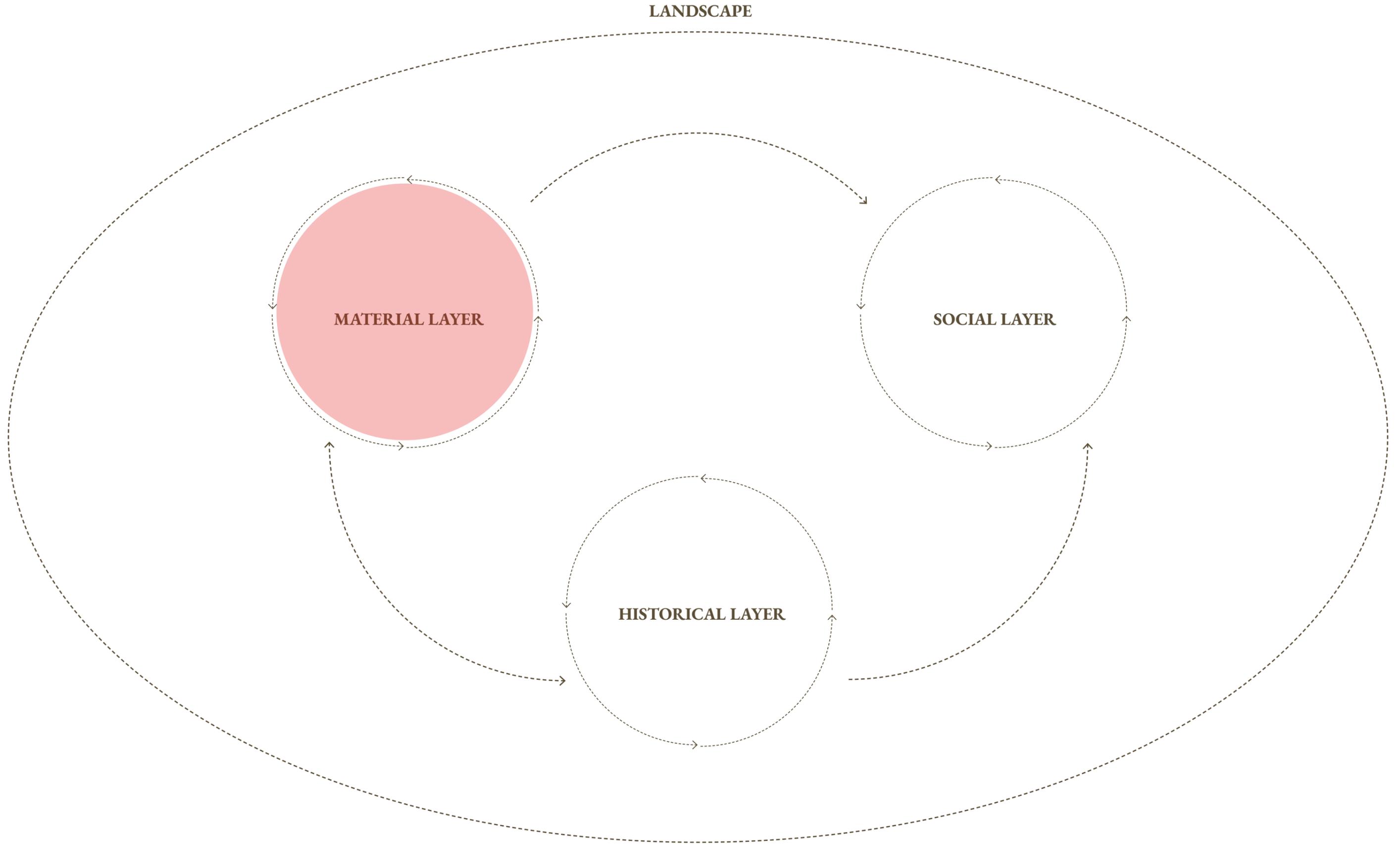


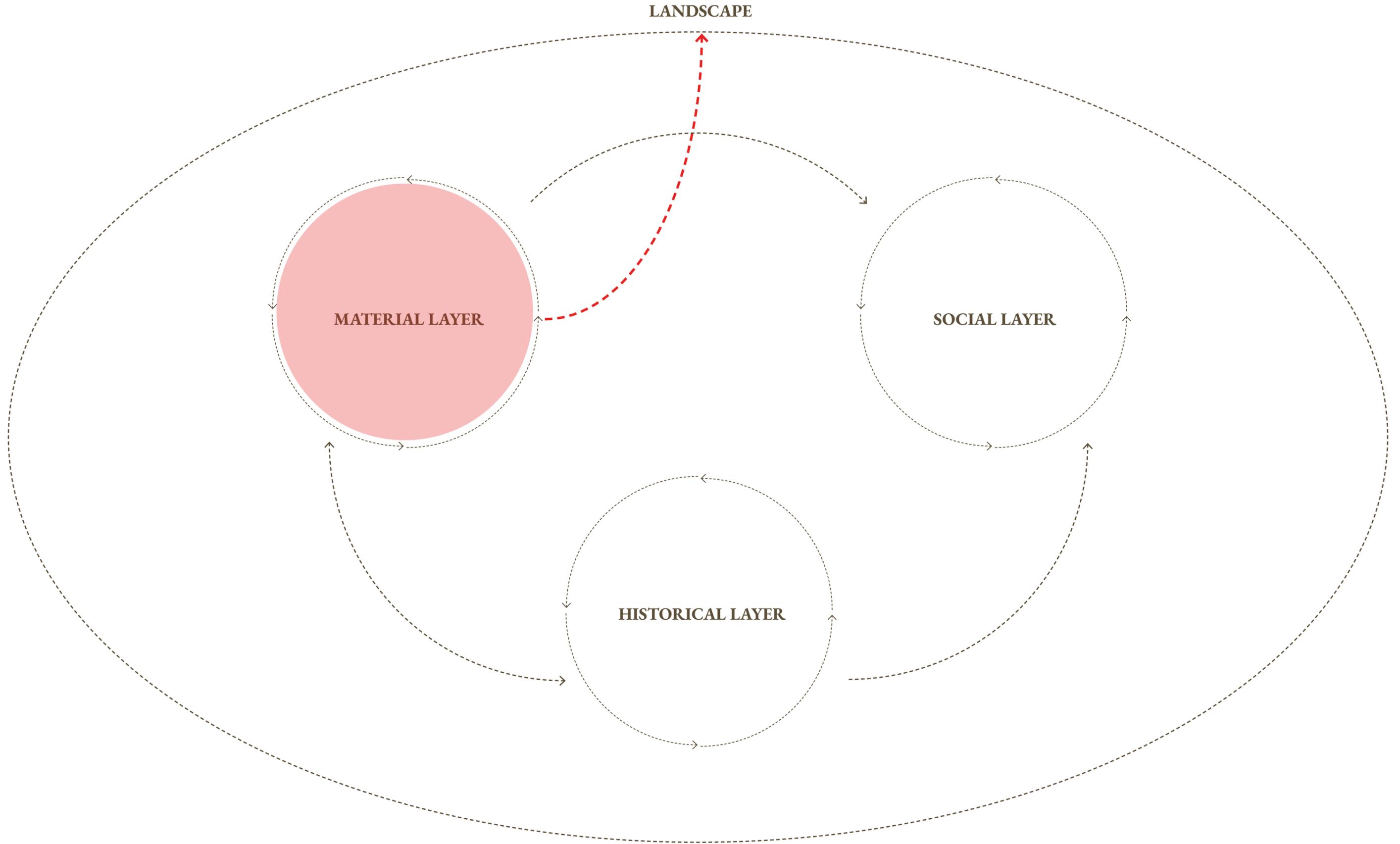
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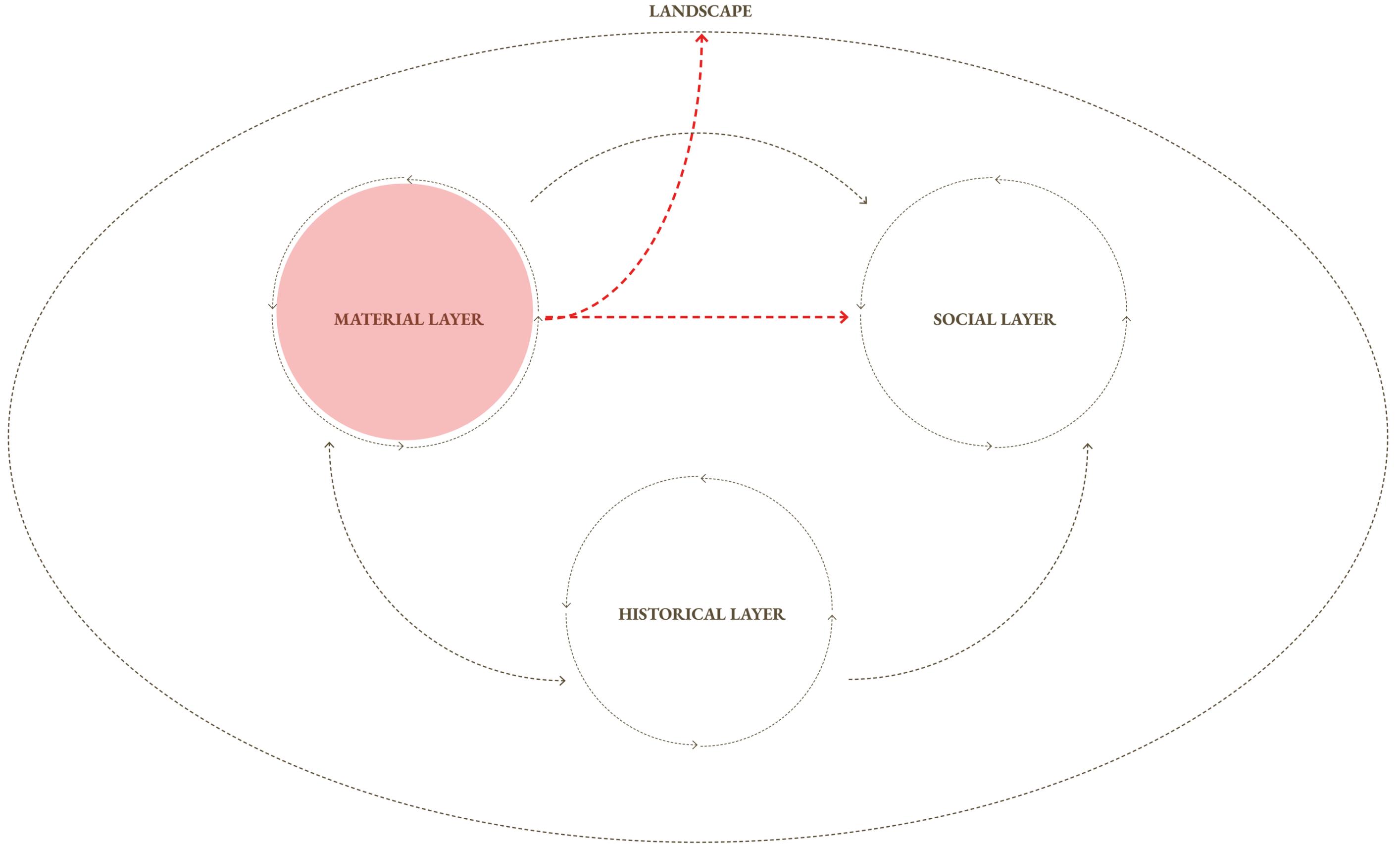
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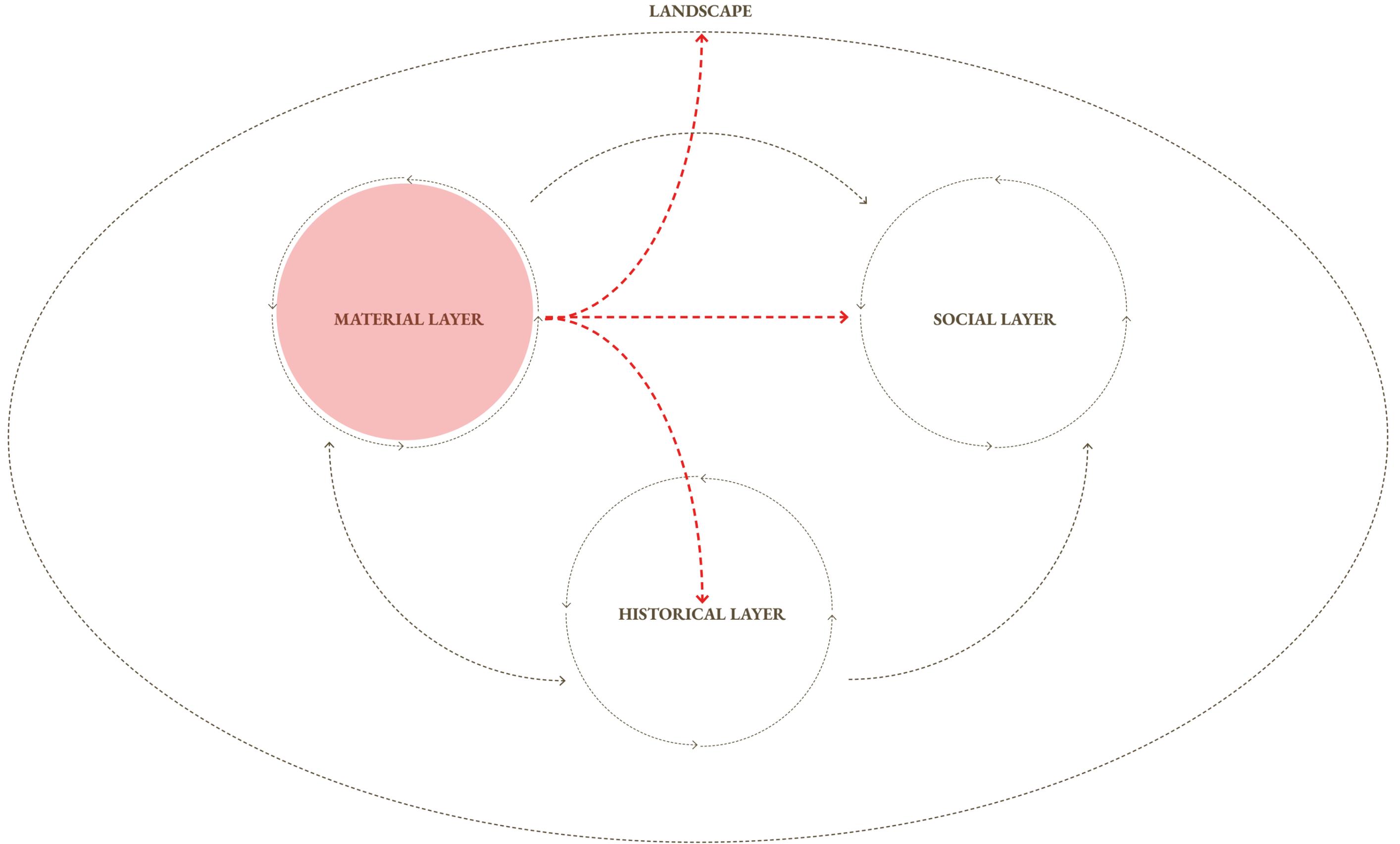












dunes - bunker

permanence & transience through the lens of weathering



dunes - bunker

permanence & transience through the lens of weathering



dunes - **proposal** - bunker

permanence & transience through the lens of weathering



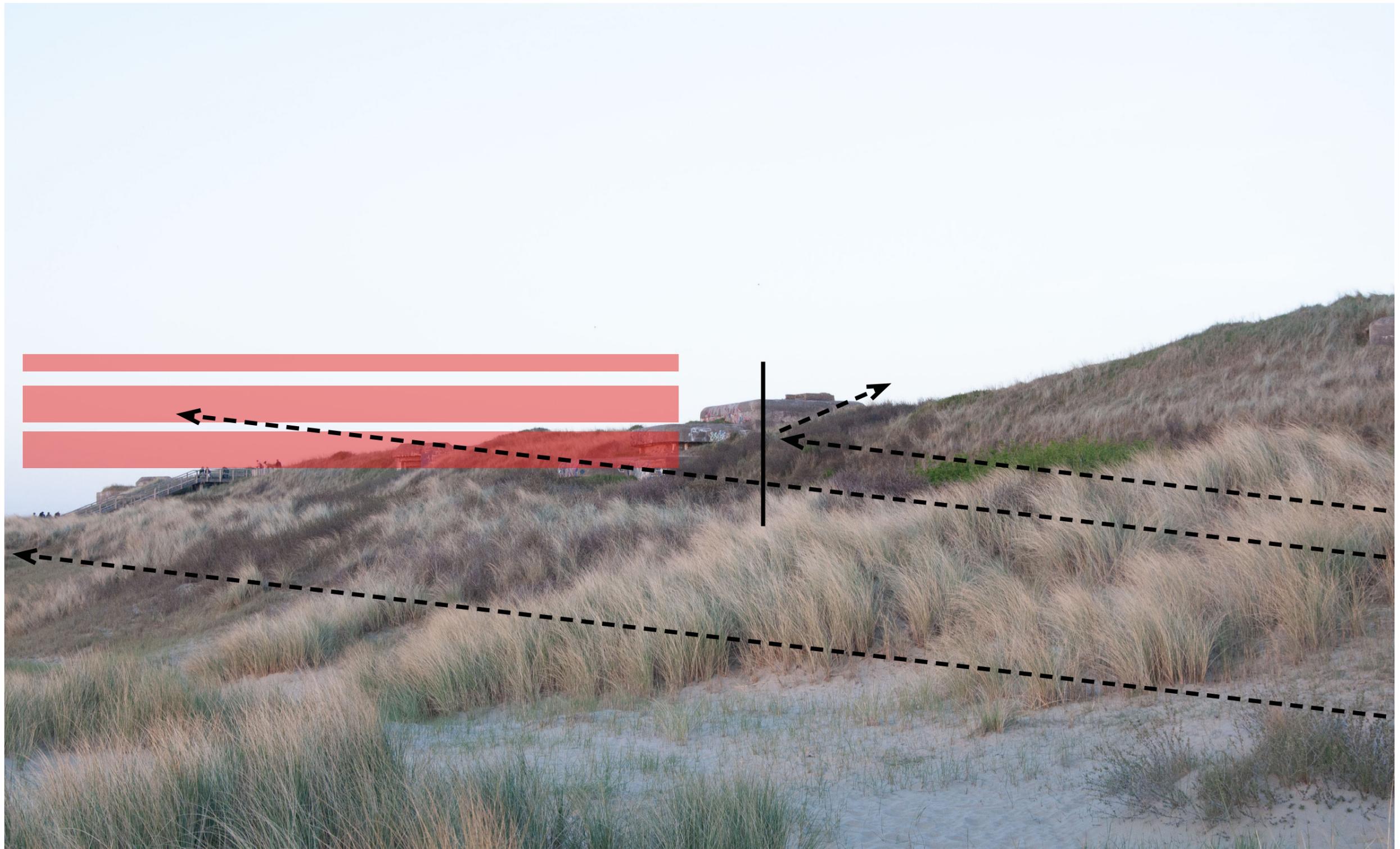
dunes - **proposal** - bunker

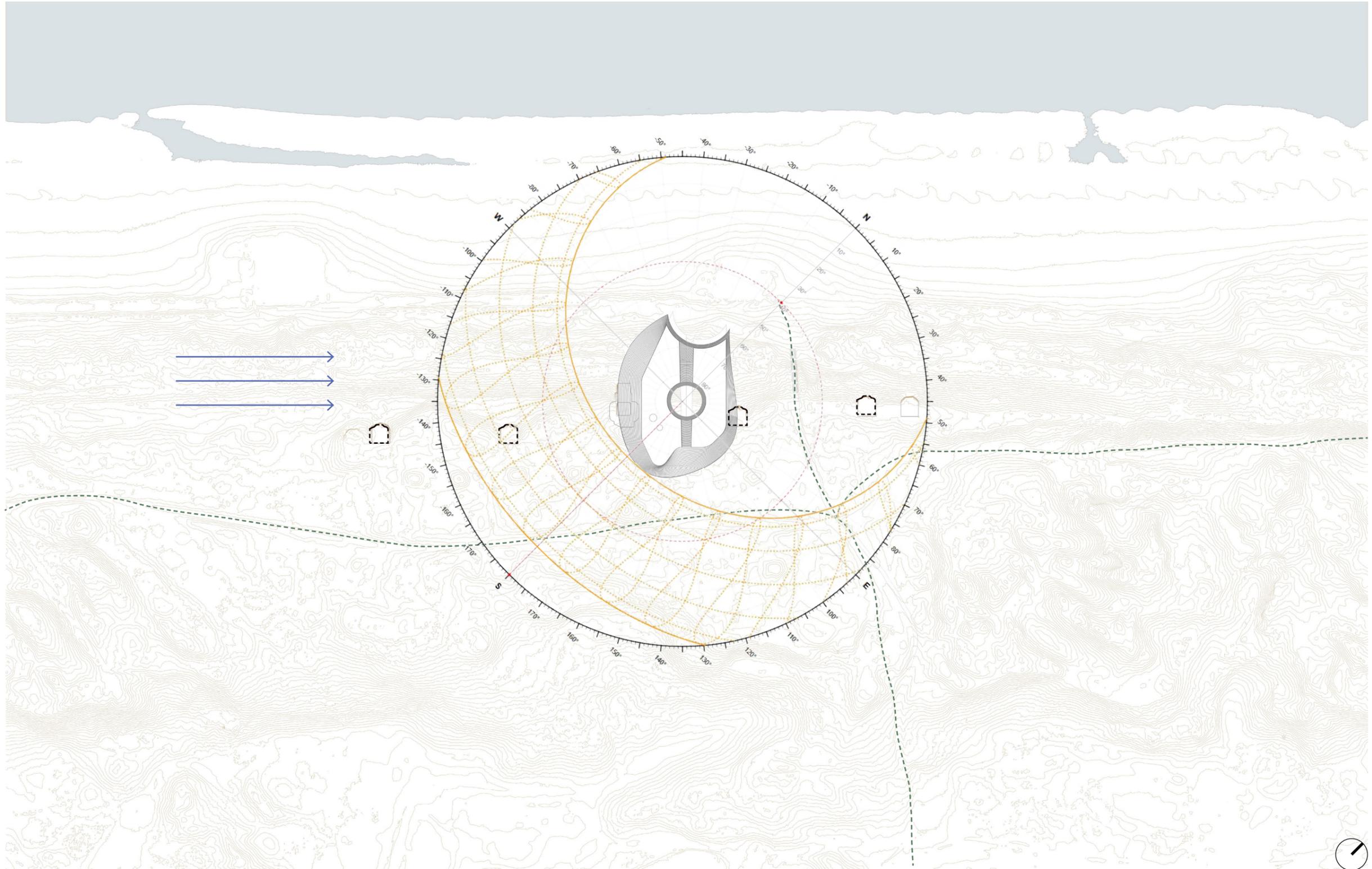
permanence & transience through the lens of weathering



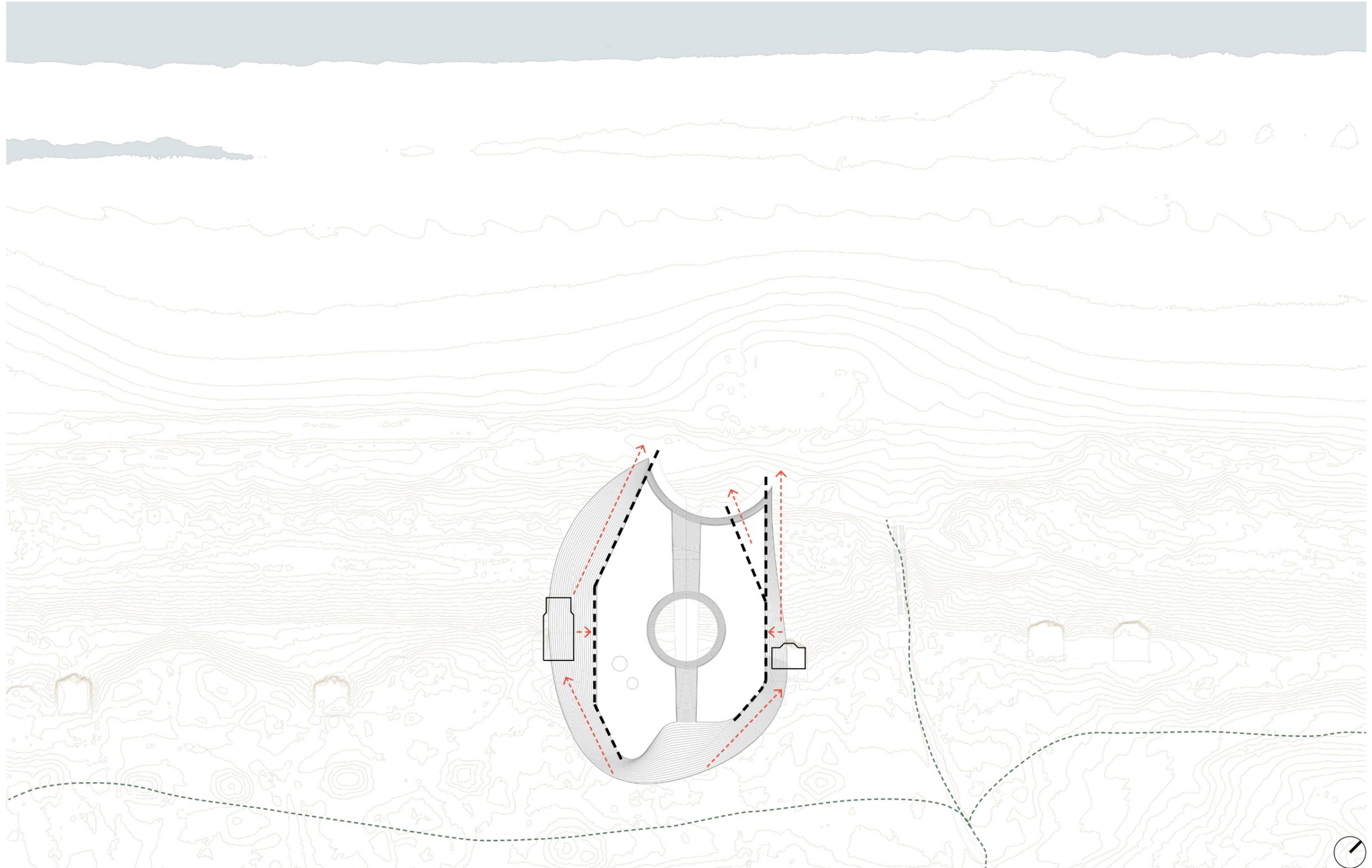
dunes - **proposal** - bunker

permanence & transience through the lens of weathering

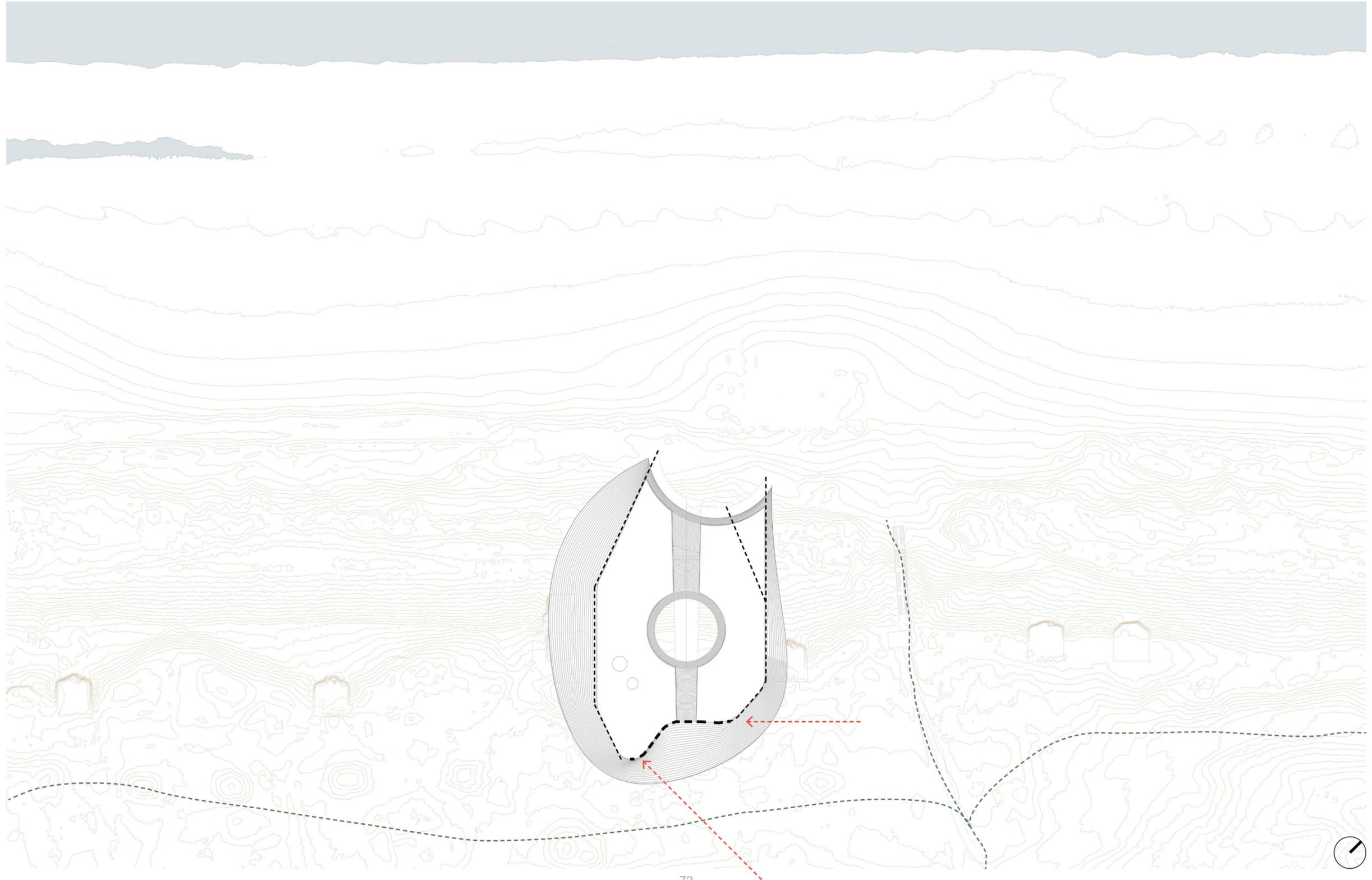




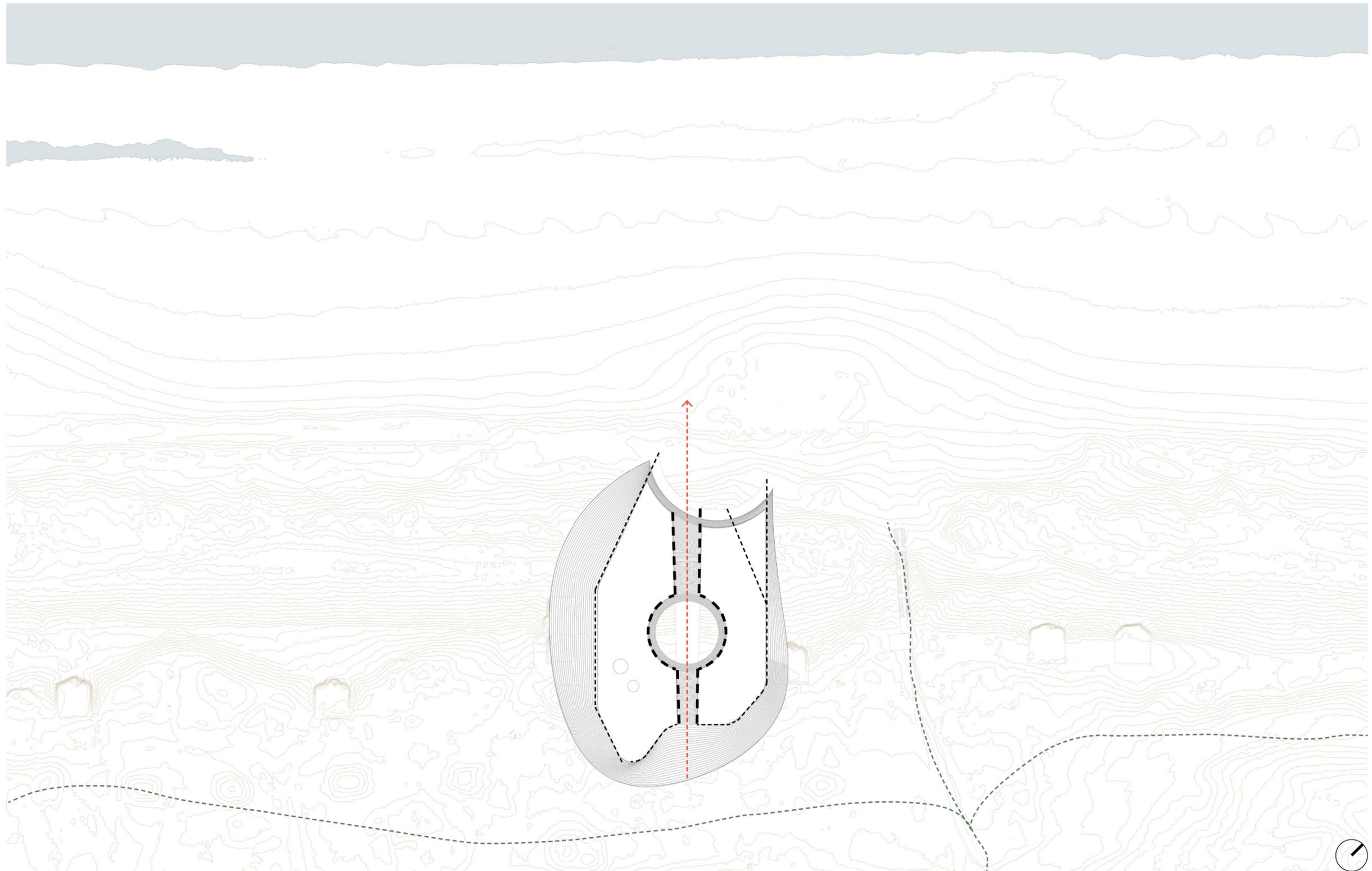
Proximity to bunkers



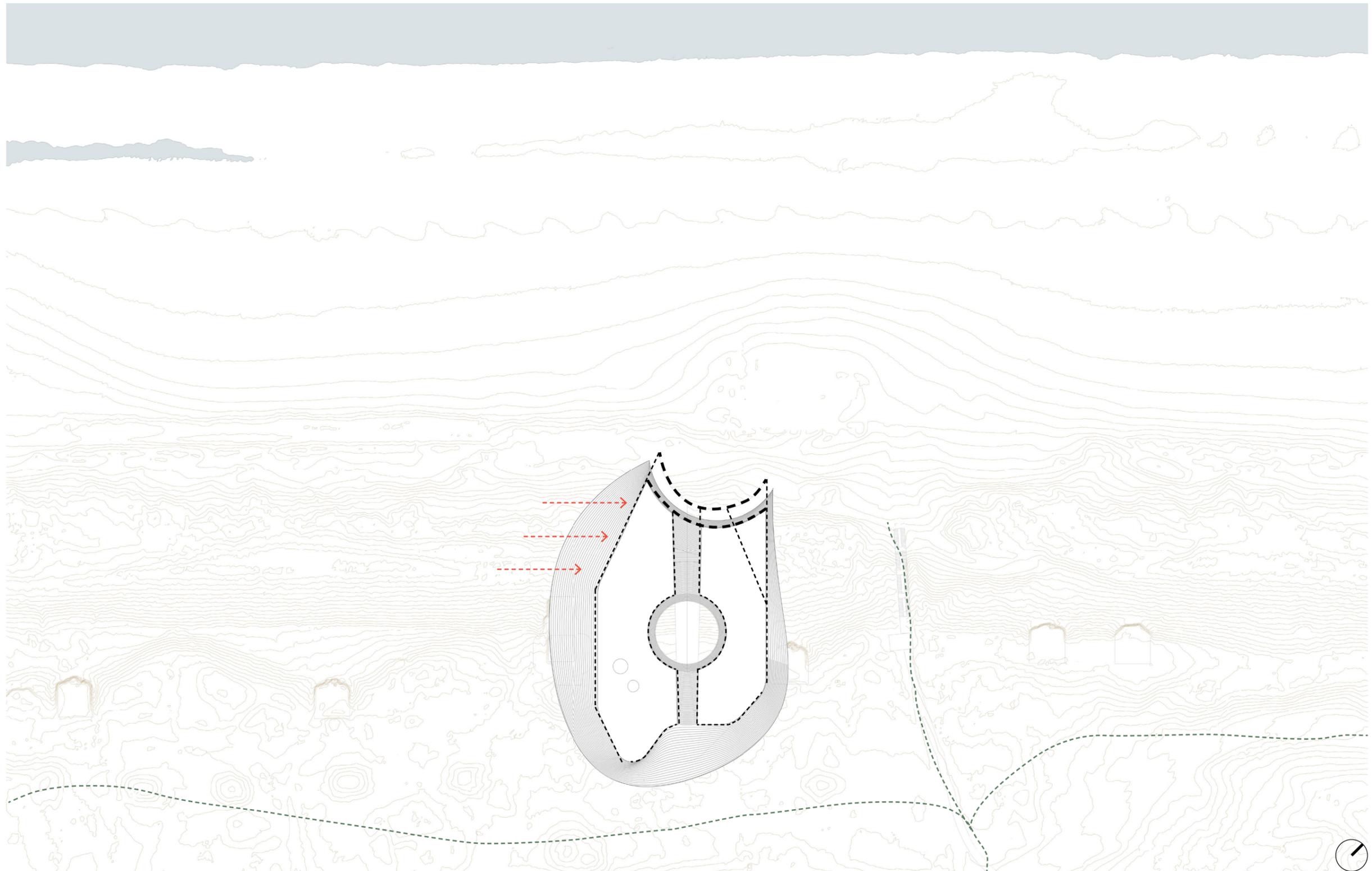
Marking the main entrance



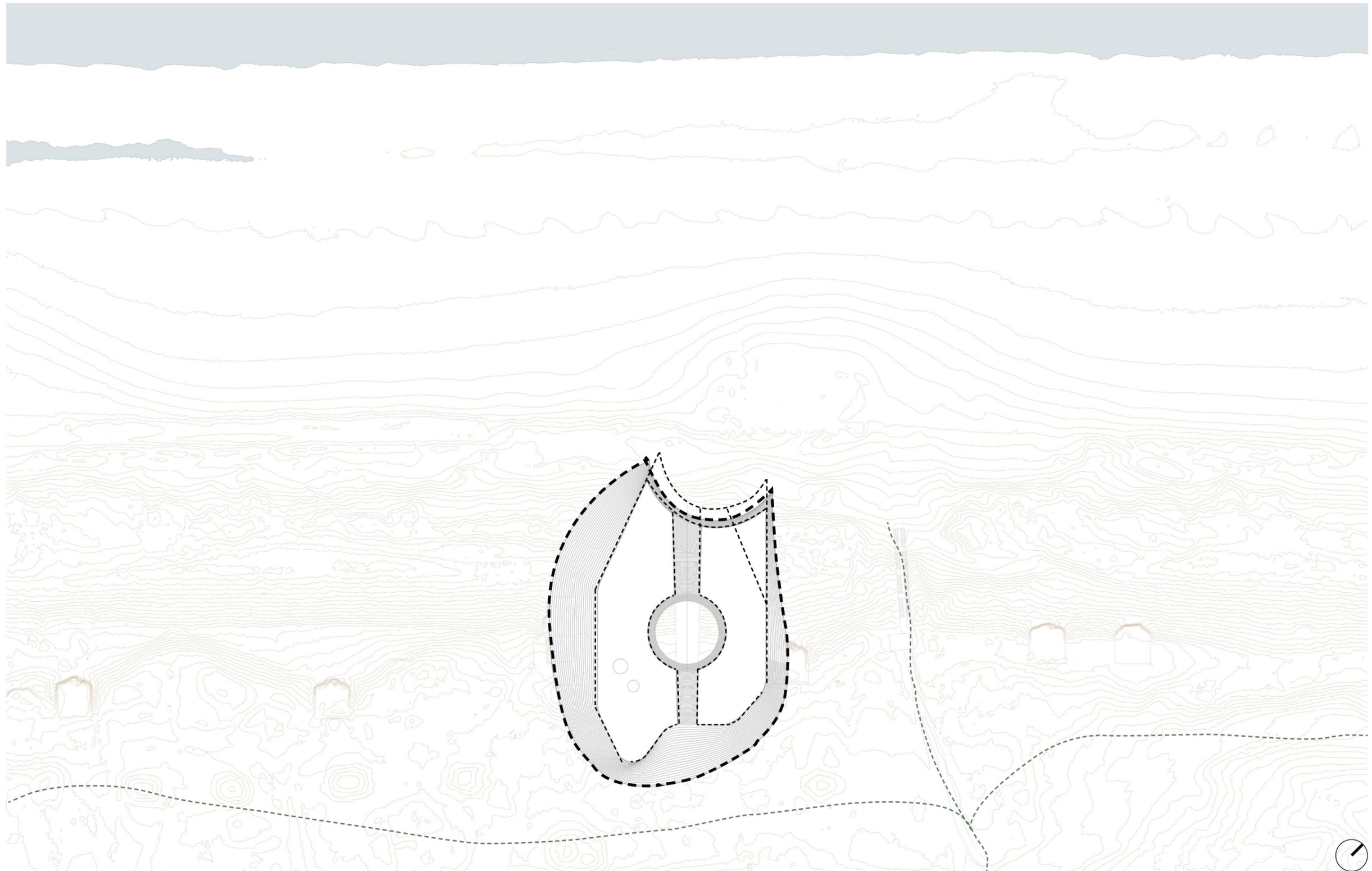
Uninterrupted view towards the sea & welcoming courtyard



Shelter the terrace towards the sea from the prevailing wind



The roof responds to the sun path and altitude in key moments of the year



Relationship between microbes and humans

The advantage of designing with microbes

environmental comfort in a changing climate

a building which ages gracefully

positive mental health impact due to natural transformative processes

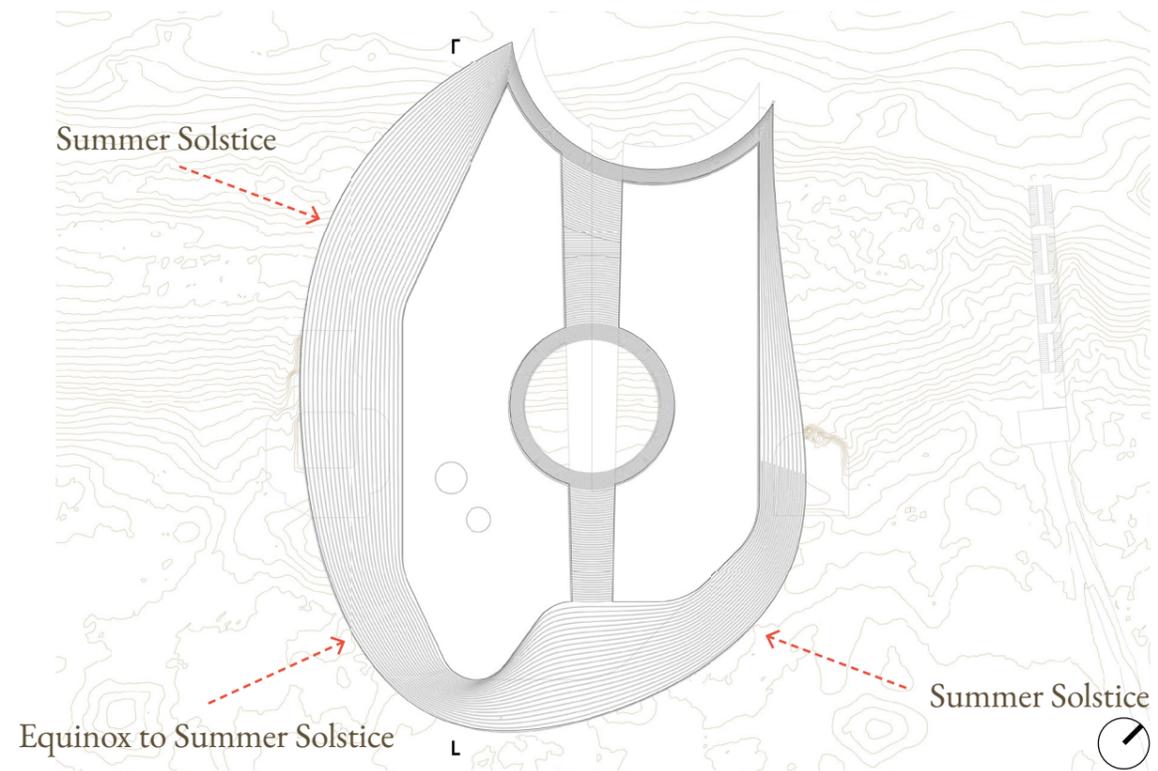


Designing with solar exposure for human comfort and fungal growth

Human comfort

Thermal comfort:

- allow heat gains in the cold season, prevent them in the hot season



Fungal growth

Thermal comfort:

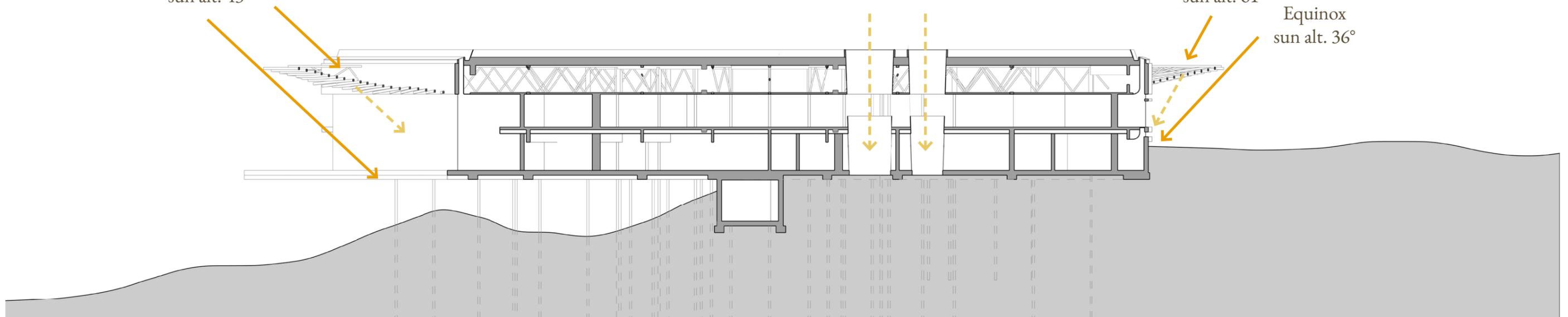
optimal fungal growth occurs between 10°C and 30°C

West Summer solstice sun alt. 43°

Summer solstice sun alt. 61°

South

Equinox sun alt. 36°

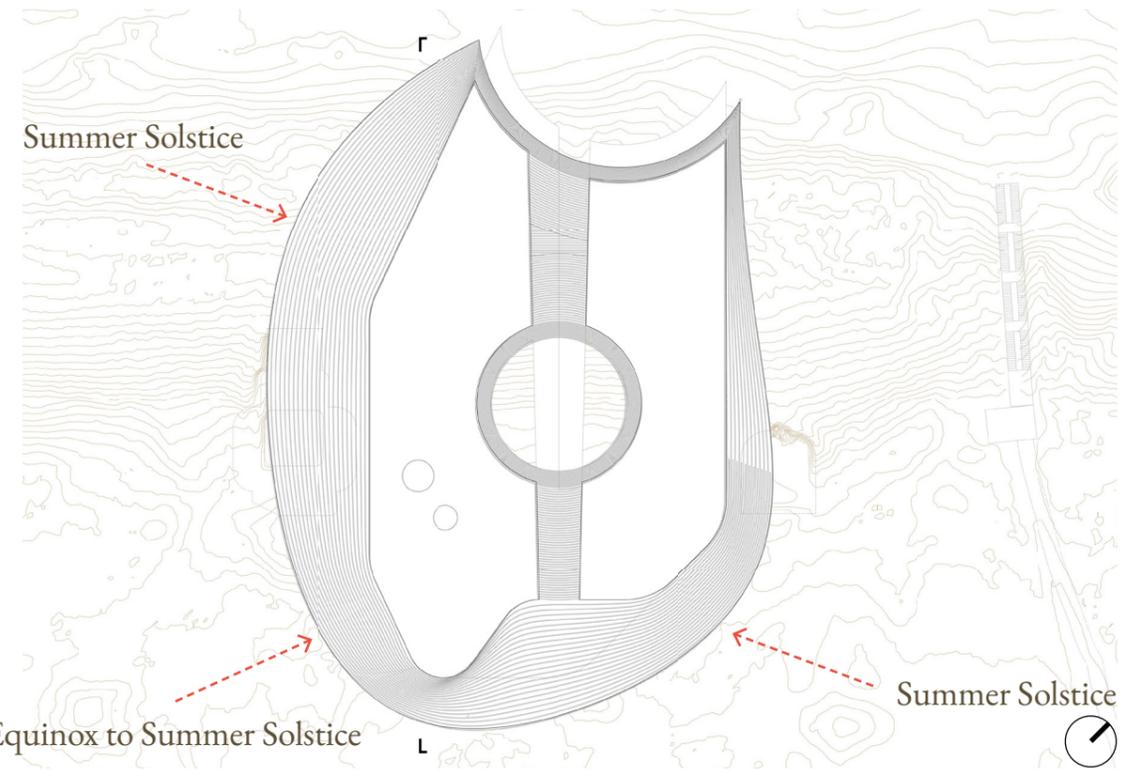


Designing with solar exposure for human comfort and fungal growth

Human comfort

Thermal comfort:

- allow heat gains in the cold season, prevent them in the hot season



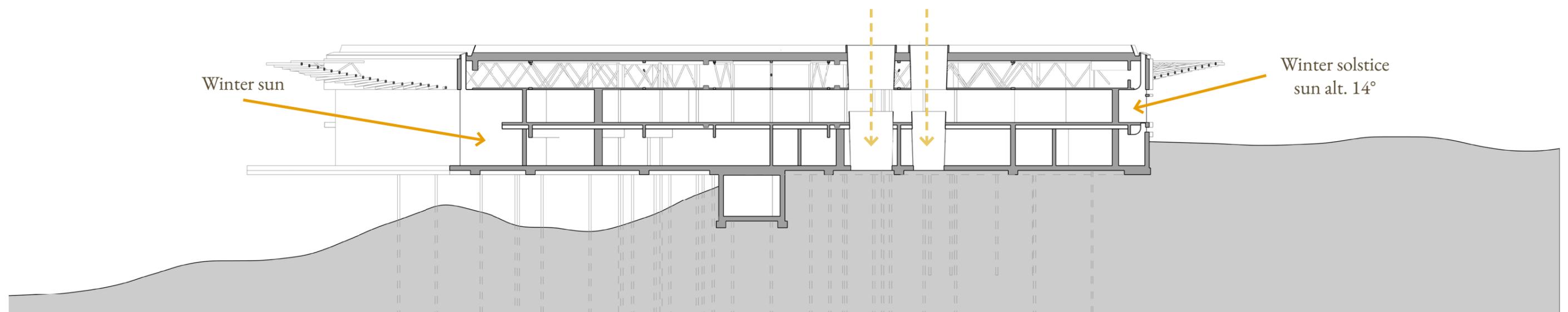
Fungal growth

Thermal comfort:

optimal fungal growth occurs between 10°C and 30°C

West

South

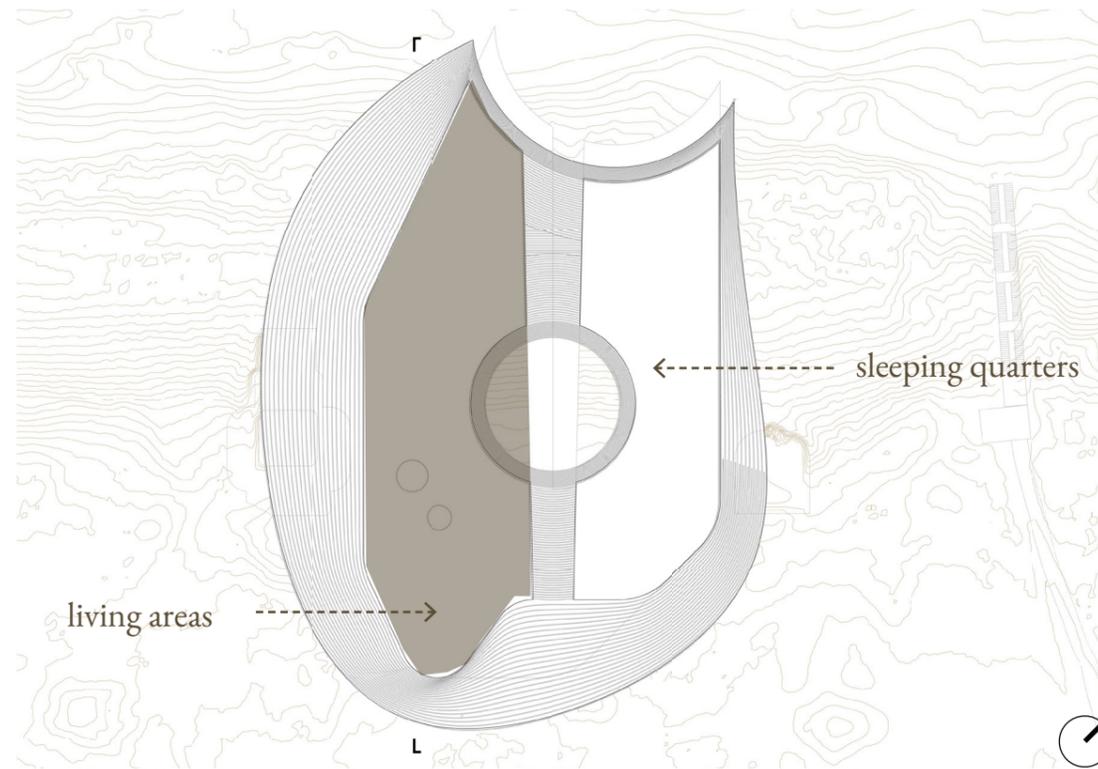


Designing with **solar exposure** for human comfort and fungal growth

Human comfort

Daylight quality:

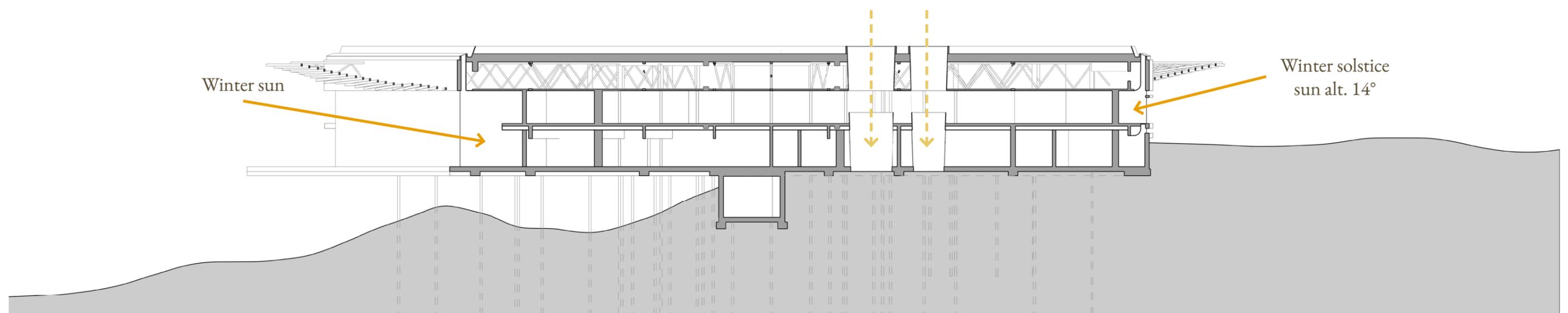
- living areas are facing the South-West, while the sleeping quarters are facing the North-East
- prevent glare and allow indirect sunlight inside



Fungal growth

West

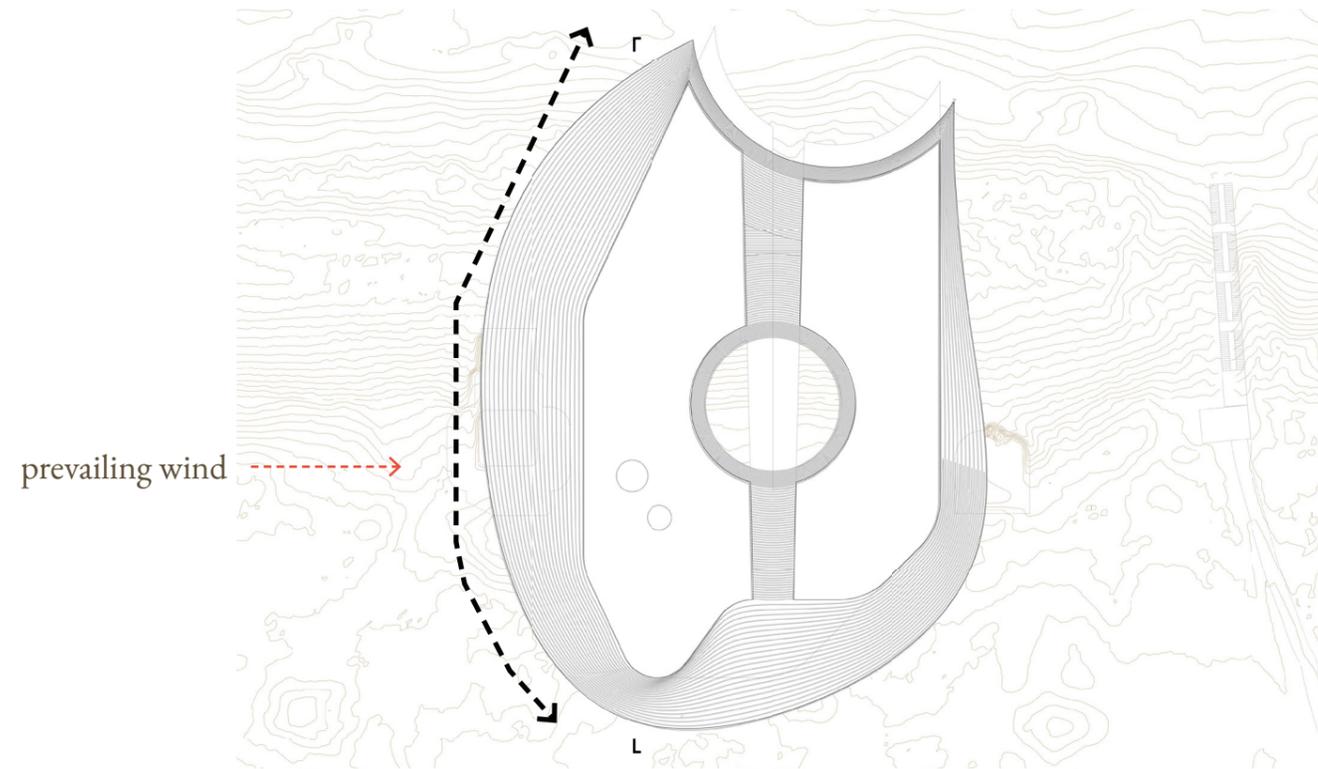
South



Designing with **wind** for human comfort and fungal growth

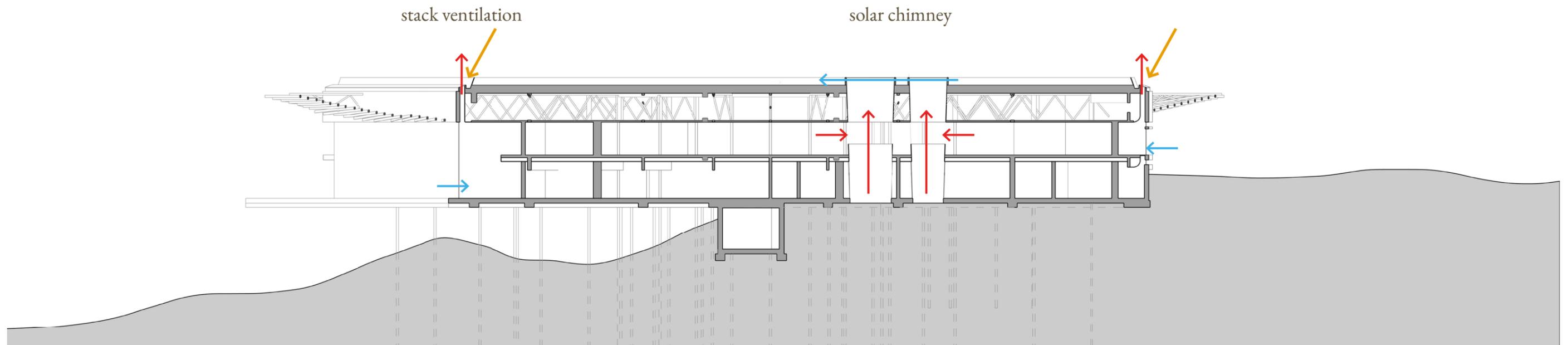
Human comfort

- prevent wind turbulence in outdoor areas
- optimise passive ventilation particularly during the hot seasons



Fungal growth

- textured surfaces retain water and prevent the microorganisms from being detached



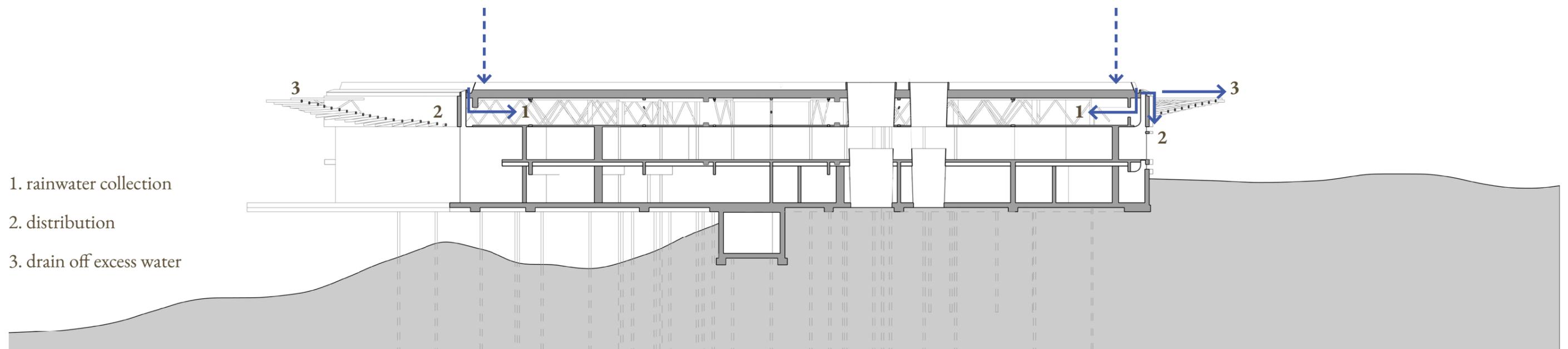
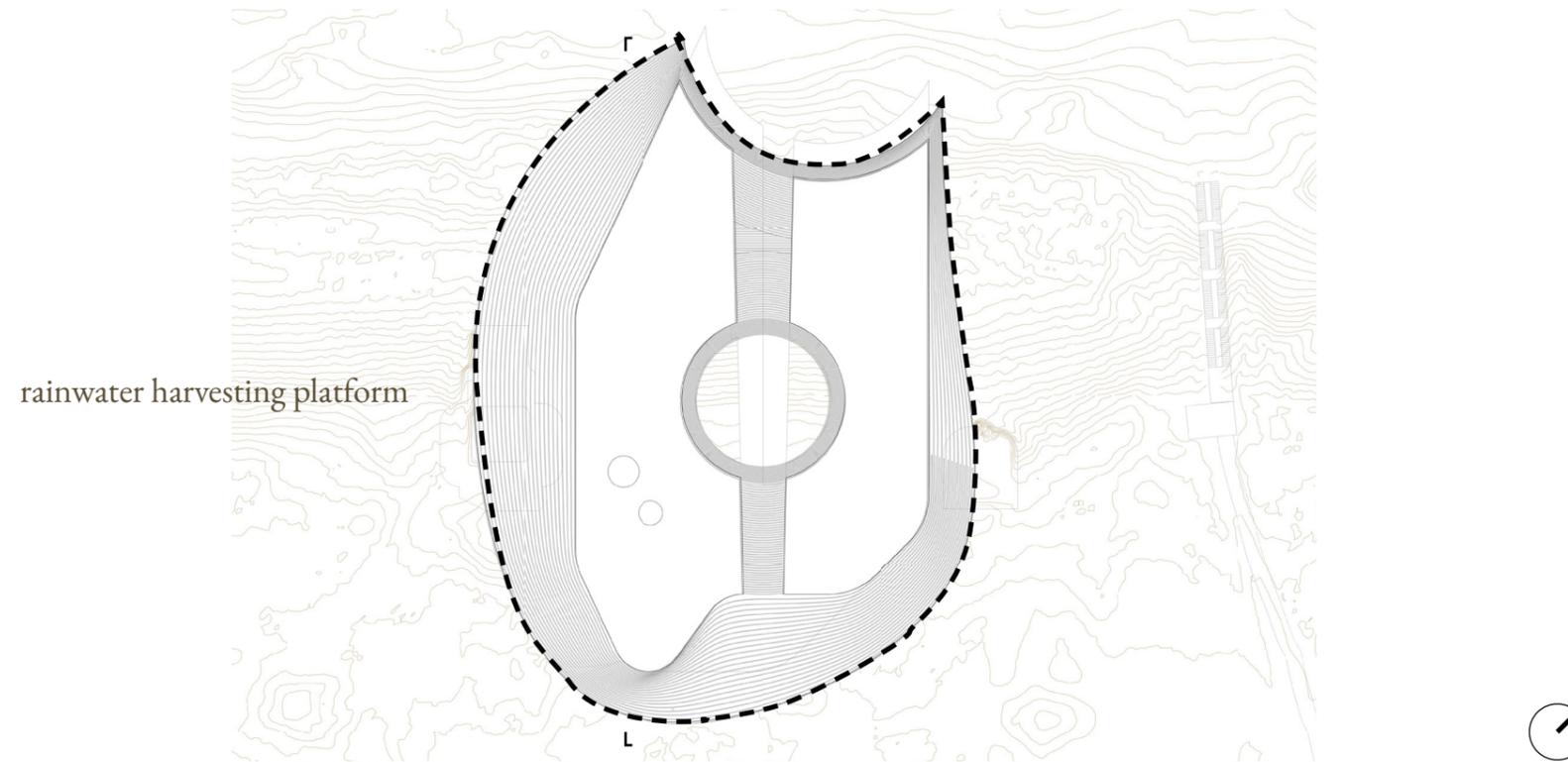
Designing with **rainwater and humidity** for human comfort and fungal growth

Human comfort

- increase the humidity level when the weather is too hot and dry
- cooling down the facade cools down the temperature inside
- reduce water consumption

Fungal growth

- persistent dampness

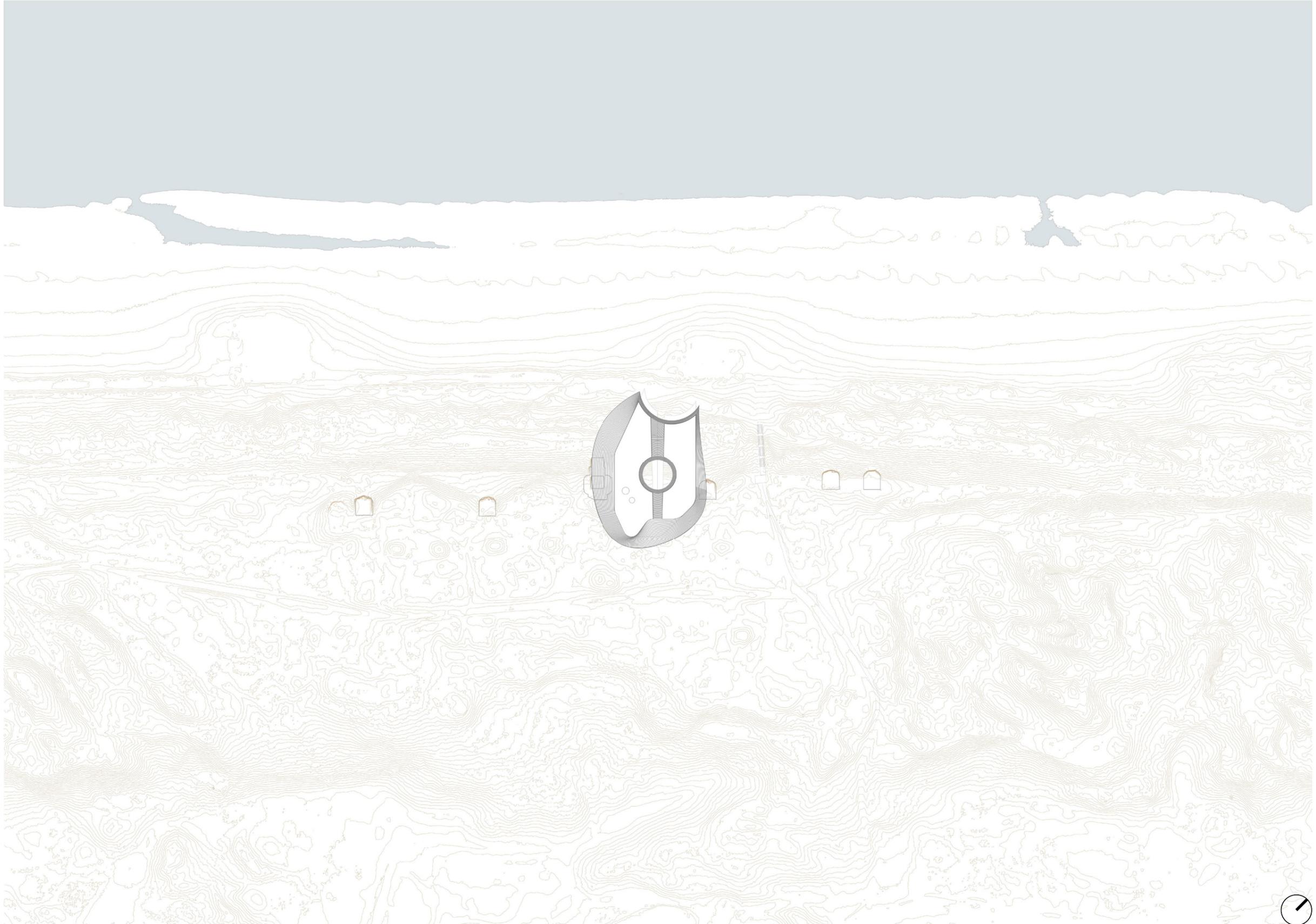


1. rainwater collection

2. distribution

3. drain off excess water

Ground floor | Scale 1:1000 @A1



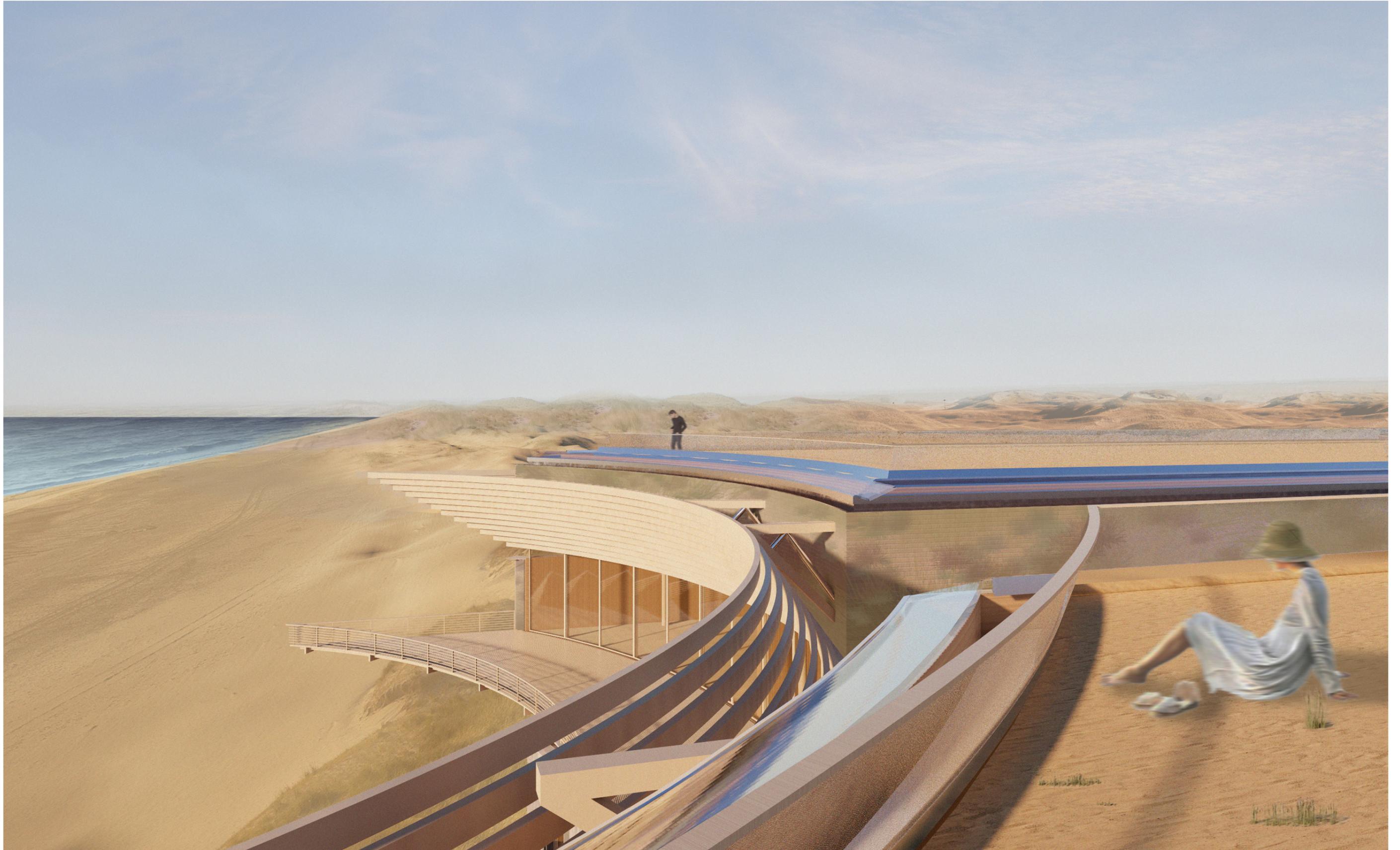
Ground floor | Scale 1:500 @A1



Context relationship

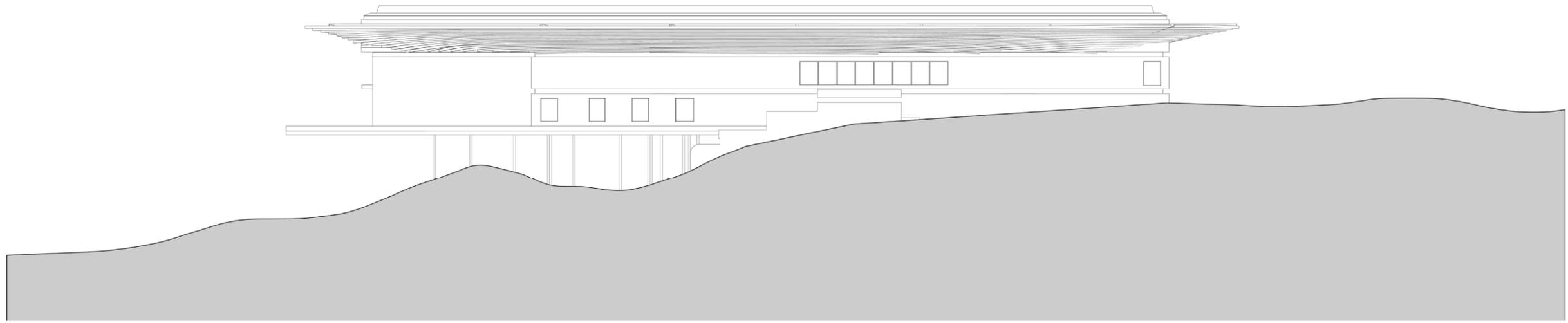


Roof garden



Landscape integration

West elevation | Scale 1:200 @A1



Landscape integration

West elevation | Scale 1:200 @A1



Landscape integration

West elevation | Scale 1:200 @A1

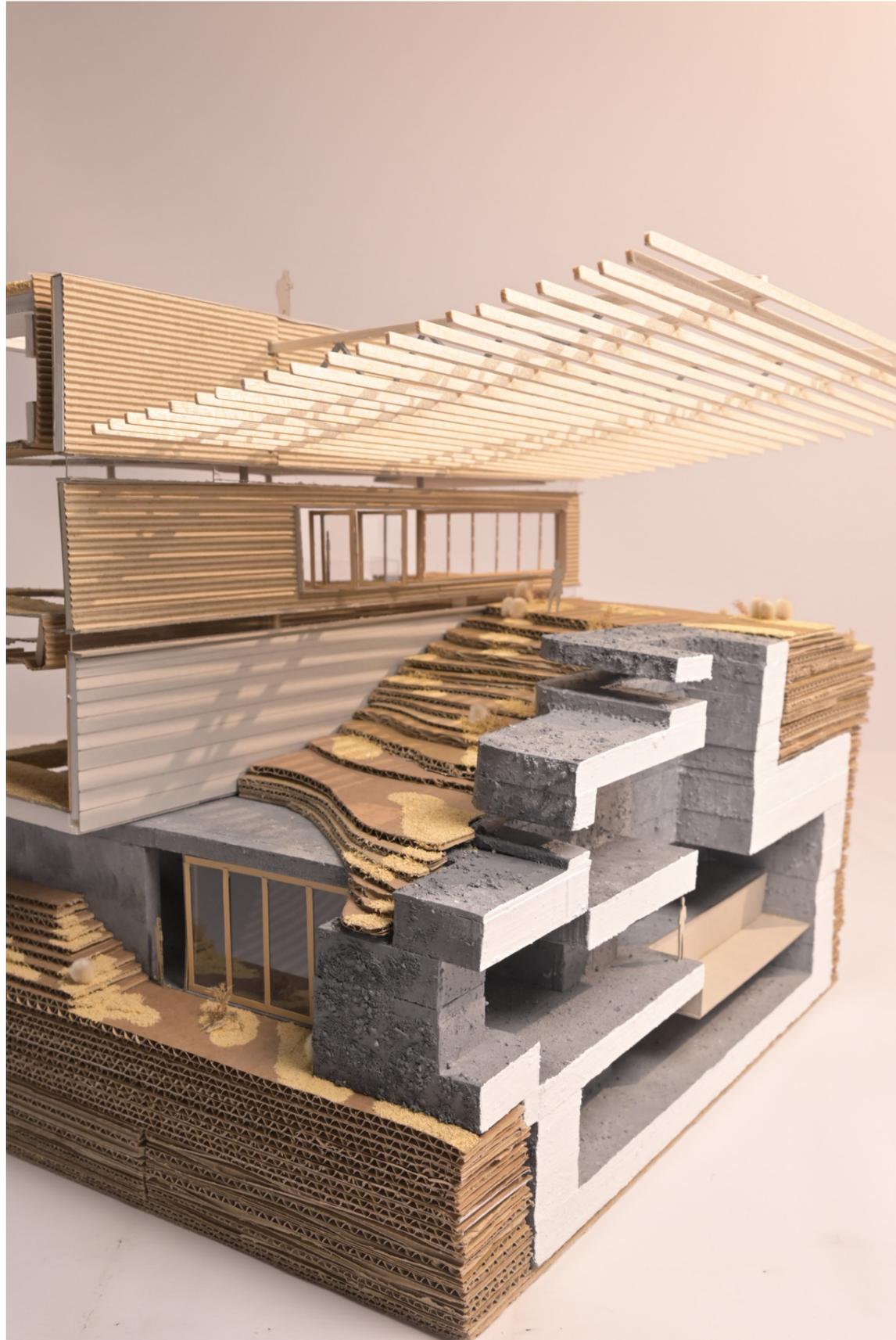


Landscape integration

West elevation | Scale 1:200 @A1

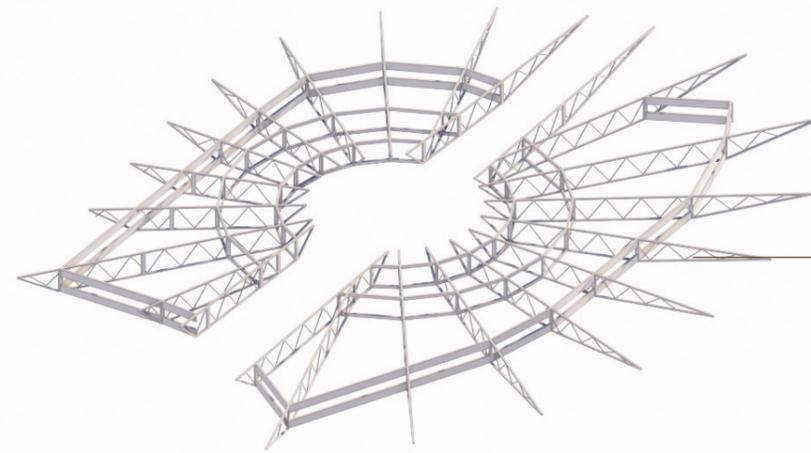




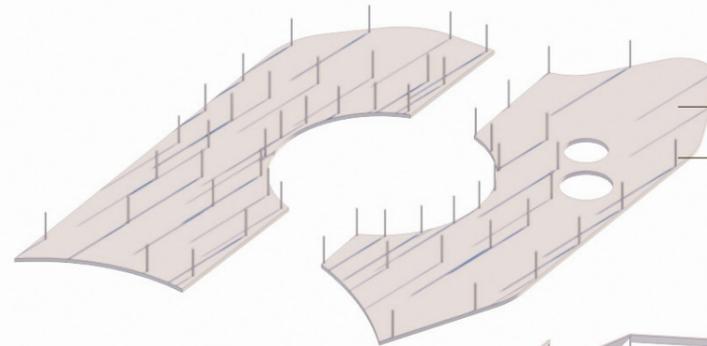


Landscape integration

Structural strategy

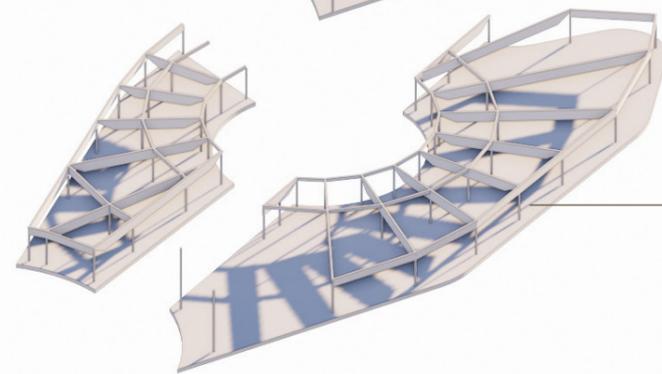


hybrid timber-steel trusses

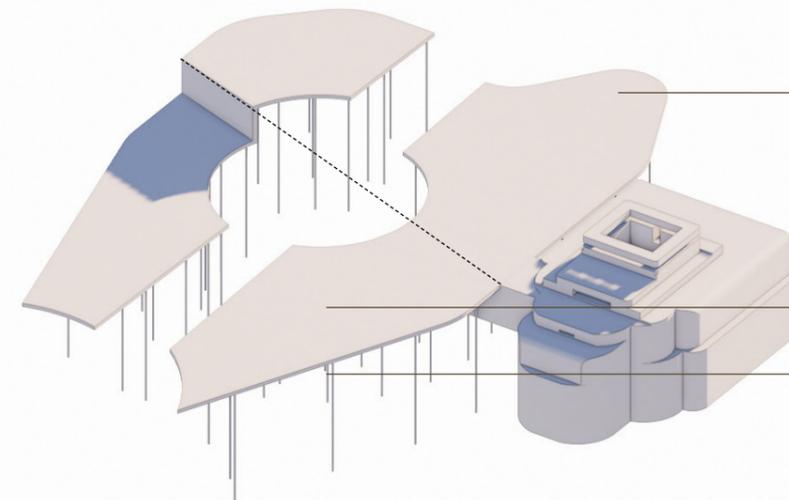


rammed earth flooring (non-structural)

glulam columns



glulam beams



fixed reinforced concrete foundation

detachable, modular concrete foundation

strip pad foundation with screw piles

1 day

1 year

50 years

100 years

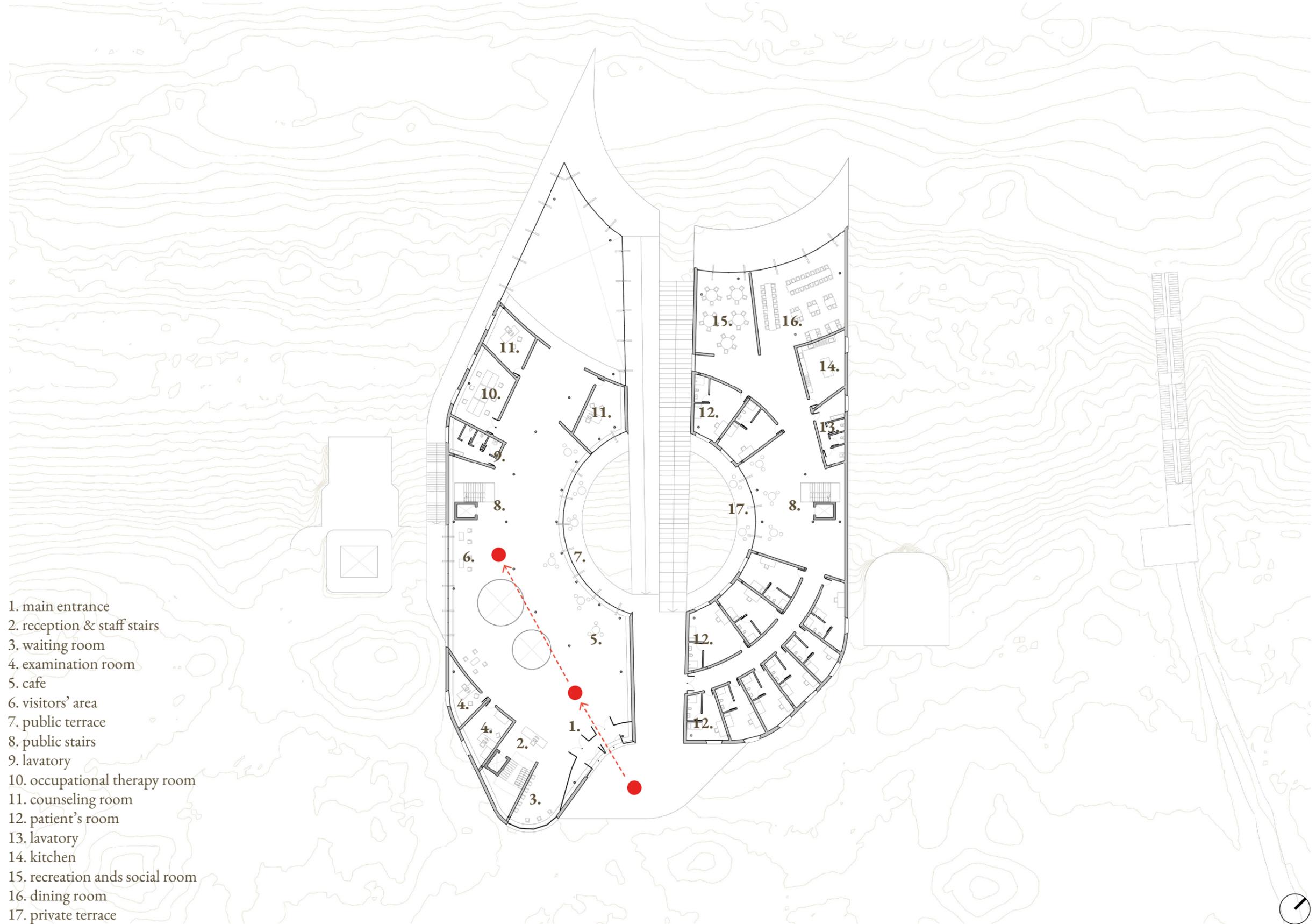
Spring

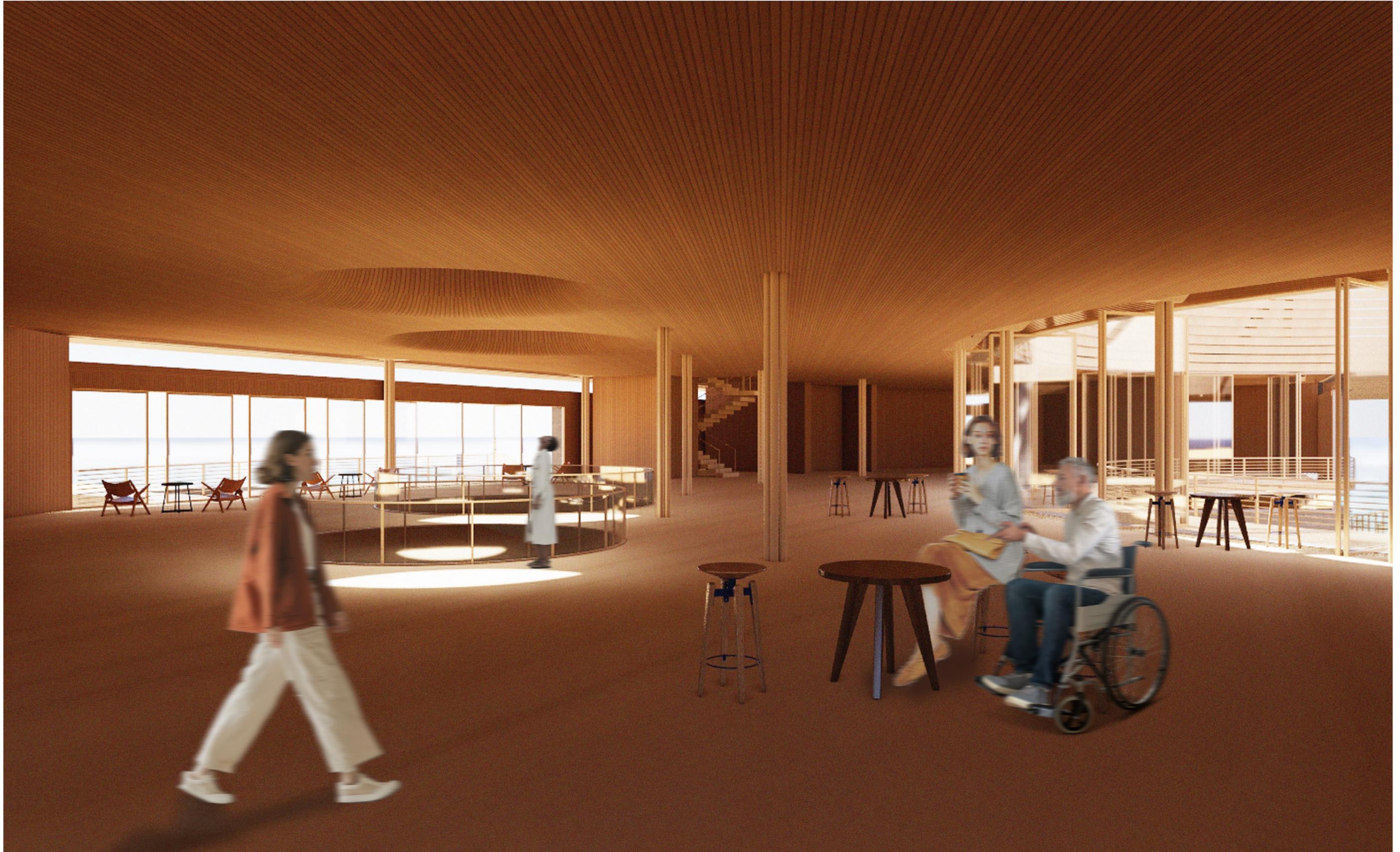
Summer

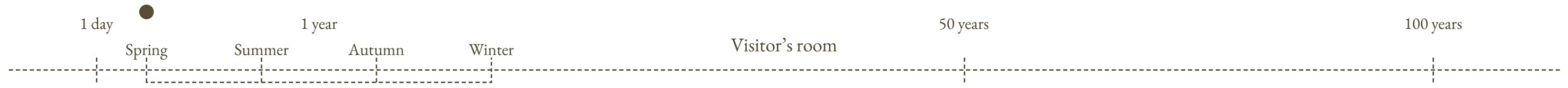
Autumn

Winter

Ground floor | Scale 1:200 @A1







1 day



1 year

50 years

100 years

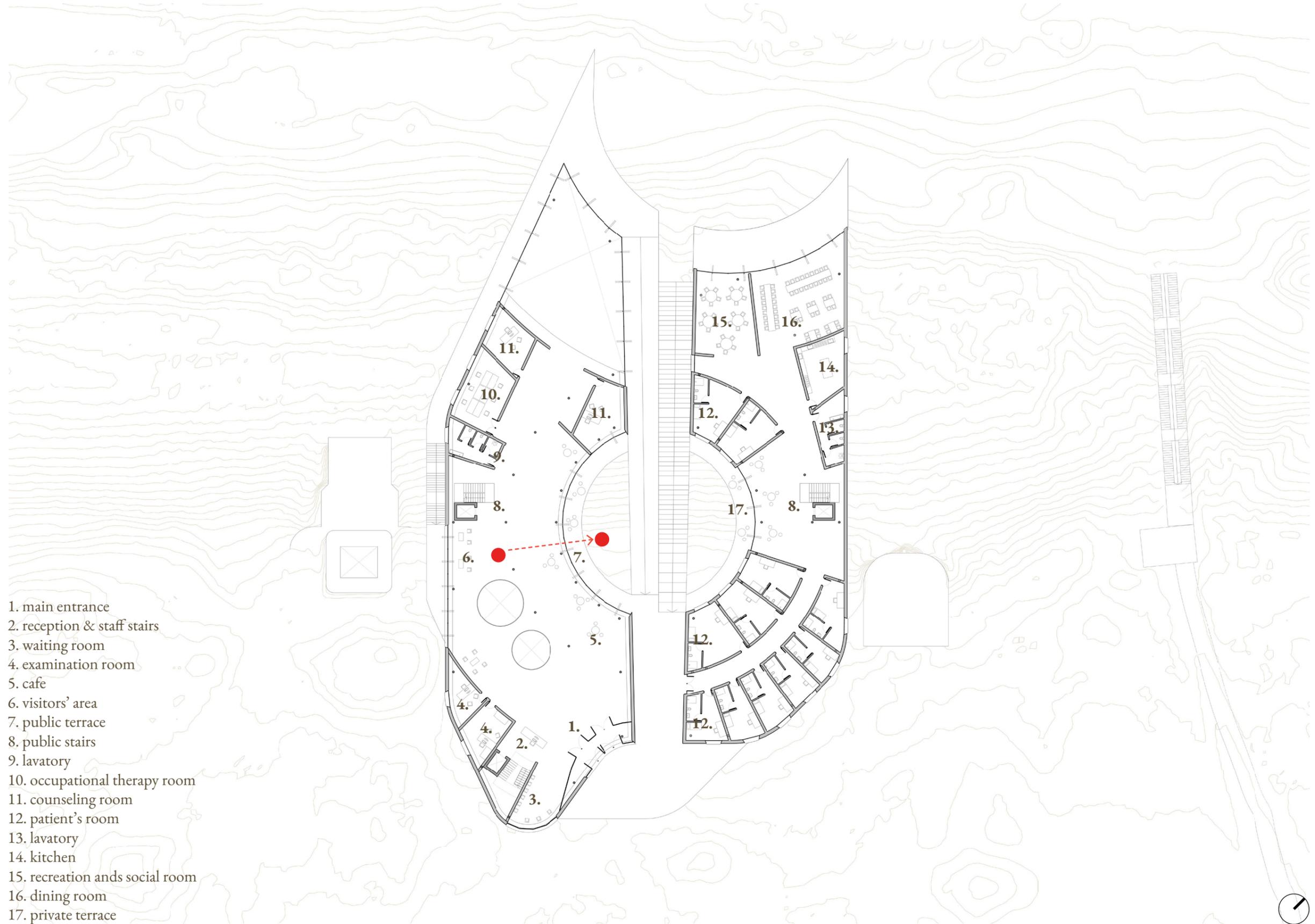
Spring

Summer

Autumn

Winter

Ground floor | Scale 1:200 @A1



- 1. main entrance
- 2. reception & staff stairs
- 3. waiting room
- 4. examination room
- 5. cafe
- 6. visitors' area
- 7. public terrace
- 8. public stairs
- 9. lavatory
- 10. occupational therapy room
- 11. counseling room
- 12. patient's room
- 13. lavatory
- 14. kitchen
- 15. recreation and social room
- 16. dining room
- 17. private terrace



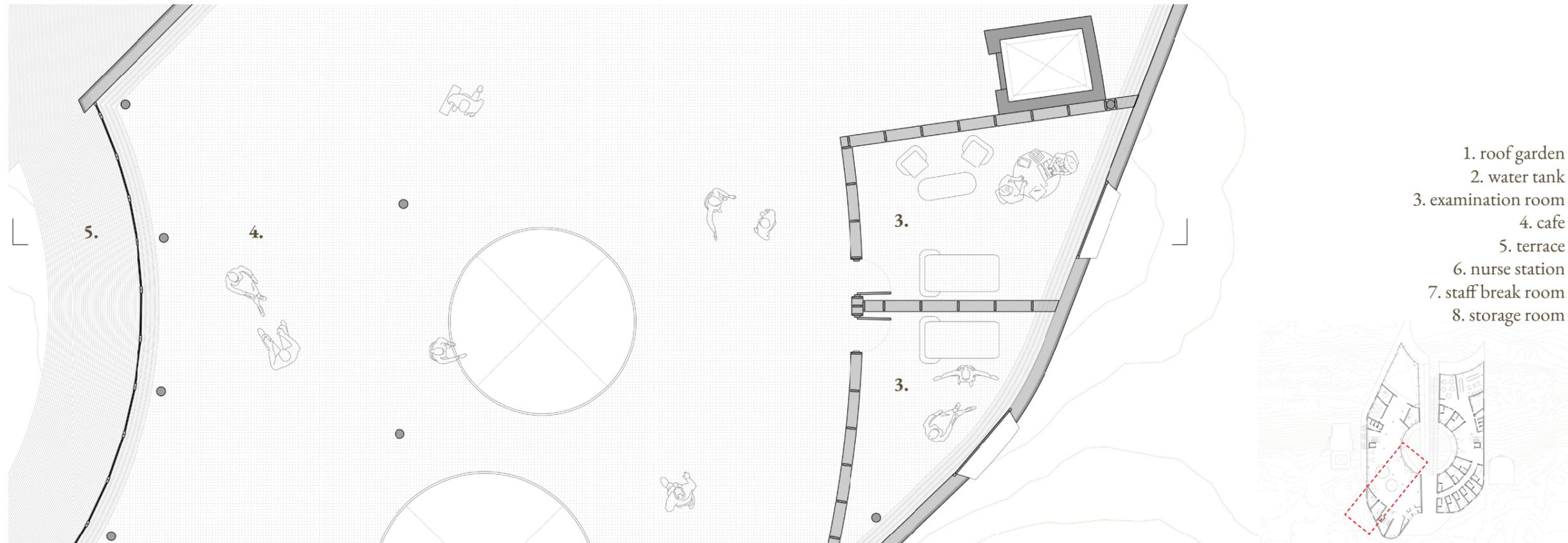
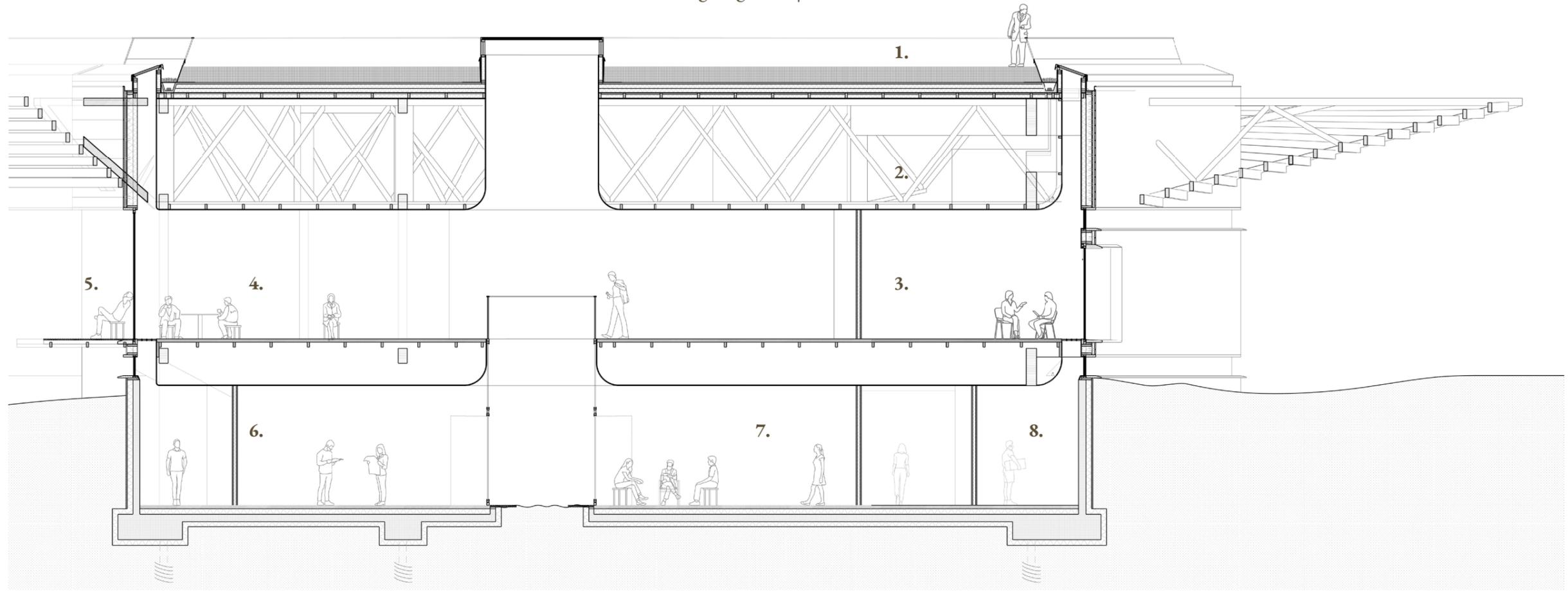
Layers of resilience

User experience



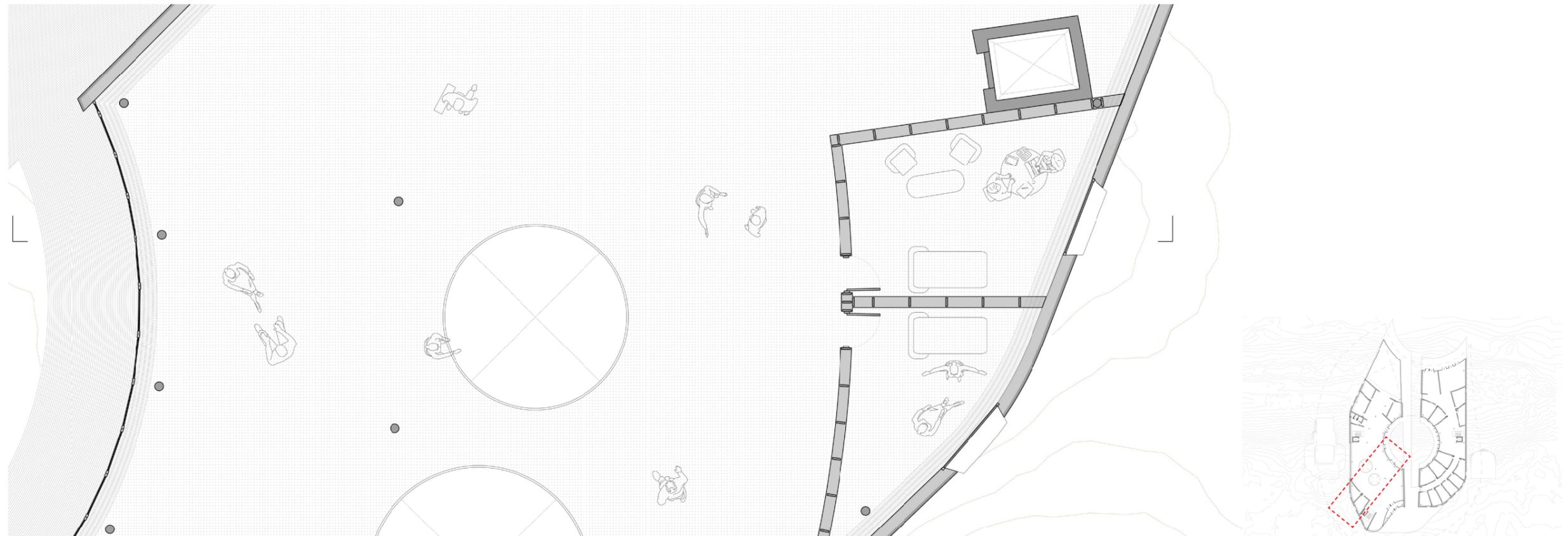
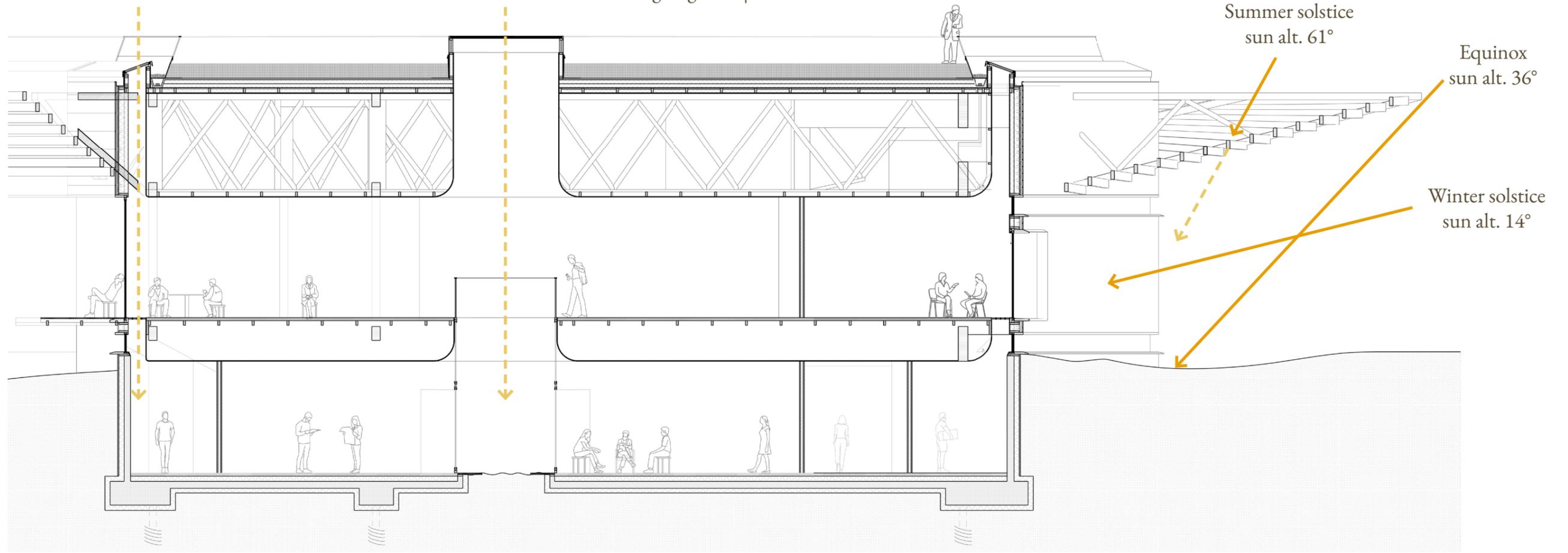
User experience

Building fragment | Scale 1:50 @A1

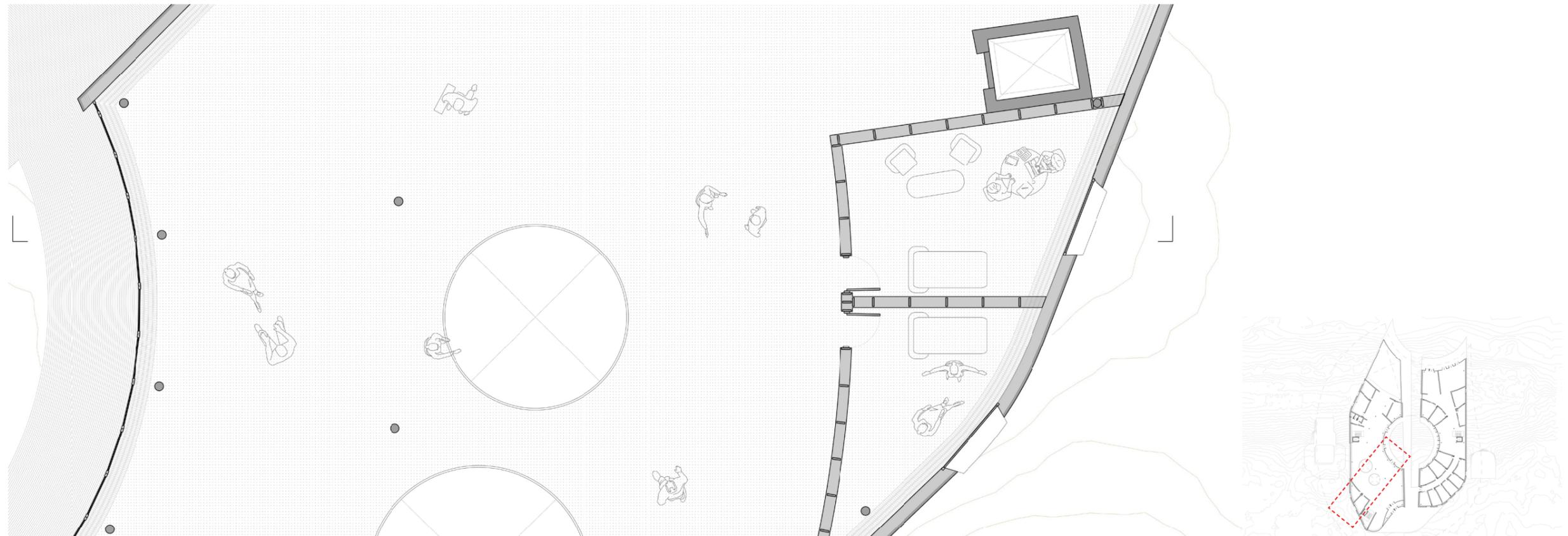
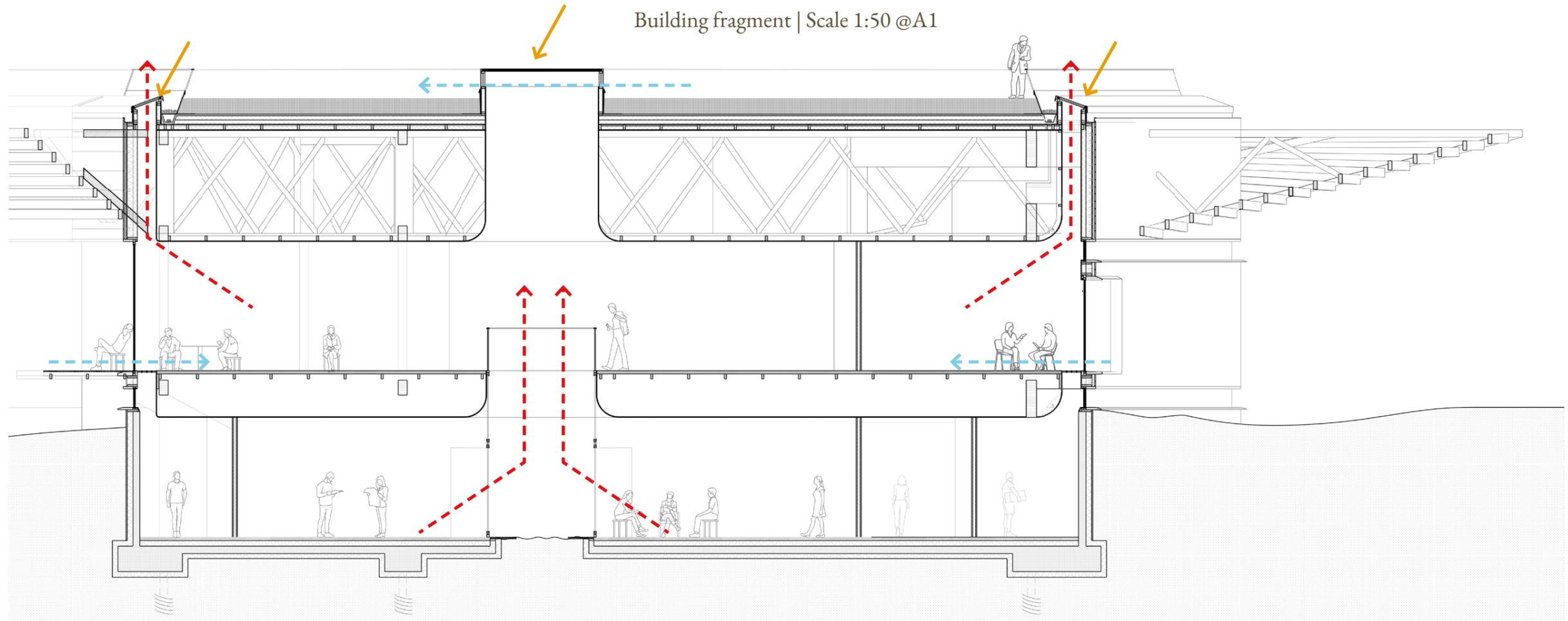


User experience

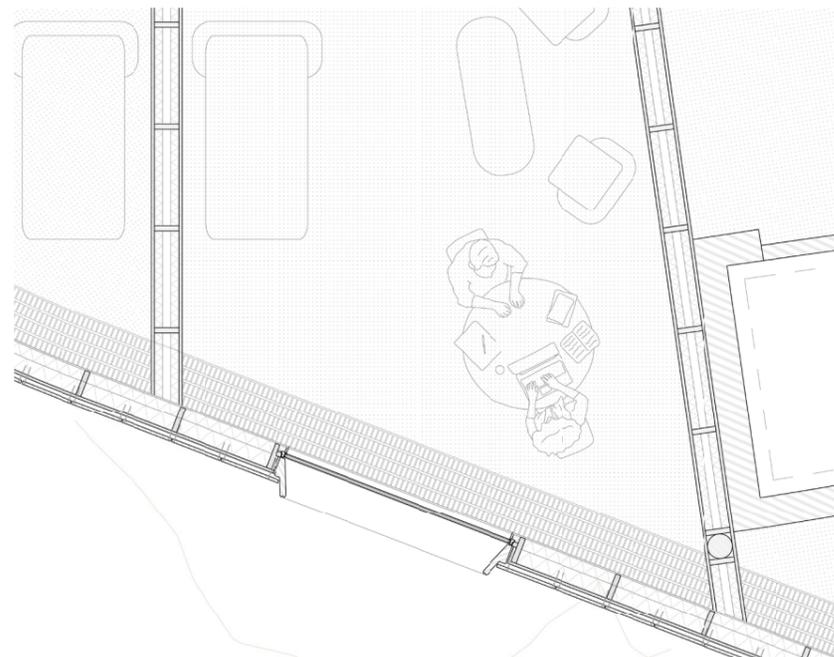
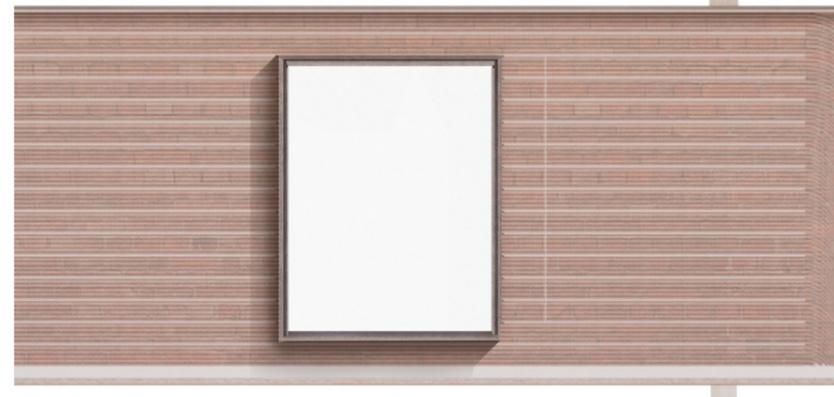
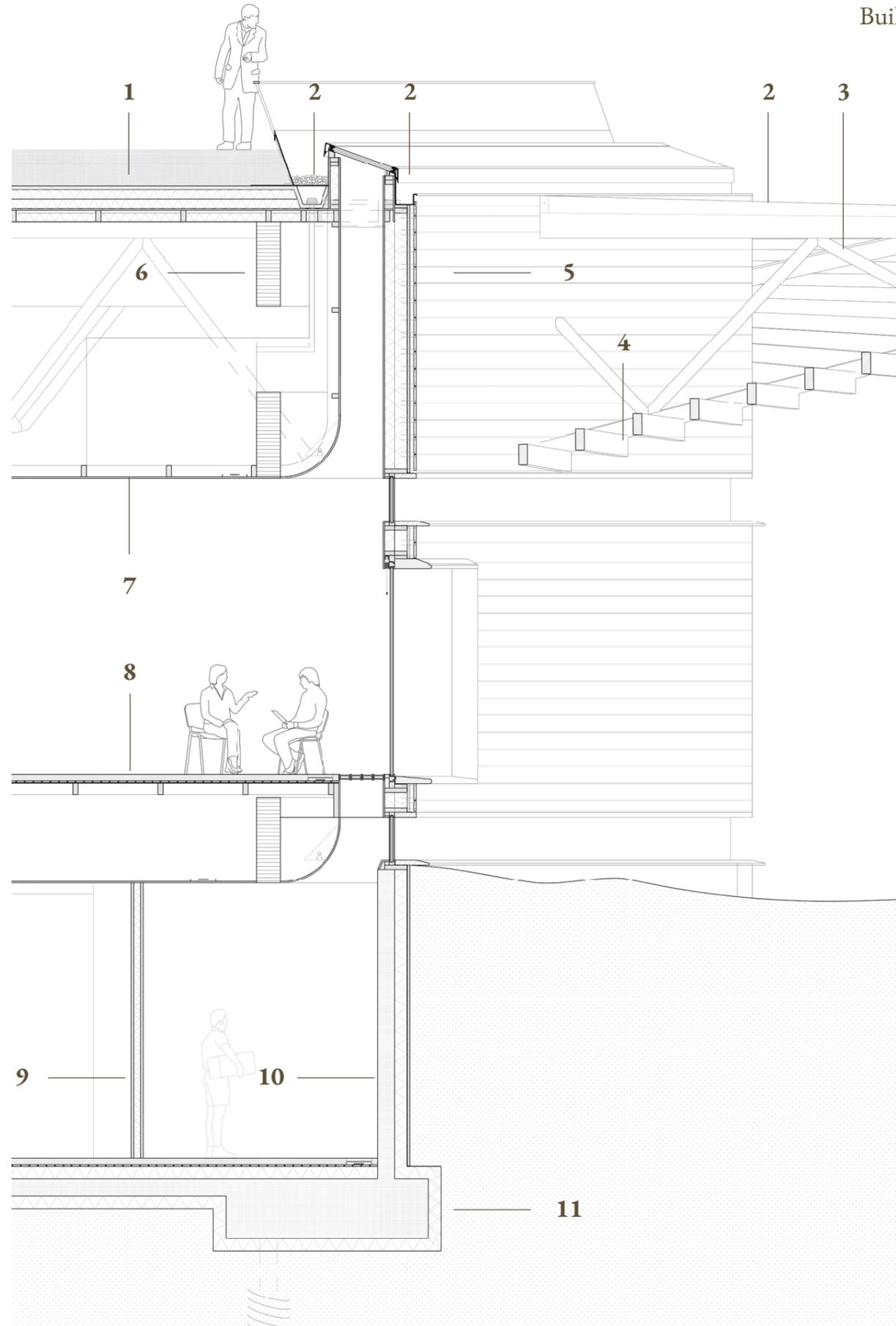
Building fragment | Scale 1:50 @A1



Building fragment | Scale 1:50 @A1



Building fragment | Scale 1:20 @A1



1. roof garden

- vegetation layer
- 430 mm sand

2. gutter(s)

- for water collection, distribution and draining off the excess

3. roof structure

- hybrid timber-steel truss

4. shading system

- fixed timber louvres

5. Southern facade cladding

- 200mmx30 mm ceramic tiles
- 50 mm ventilated cavity

6. primary structure

- 240x1000mm glued laminated timber beam

7. ceiling

- 18mm timber battens
- timber studs

8. floor

- rammed earth with underfloor heating system

9. partition wall

- timber sandwich panel

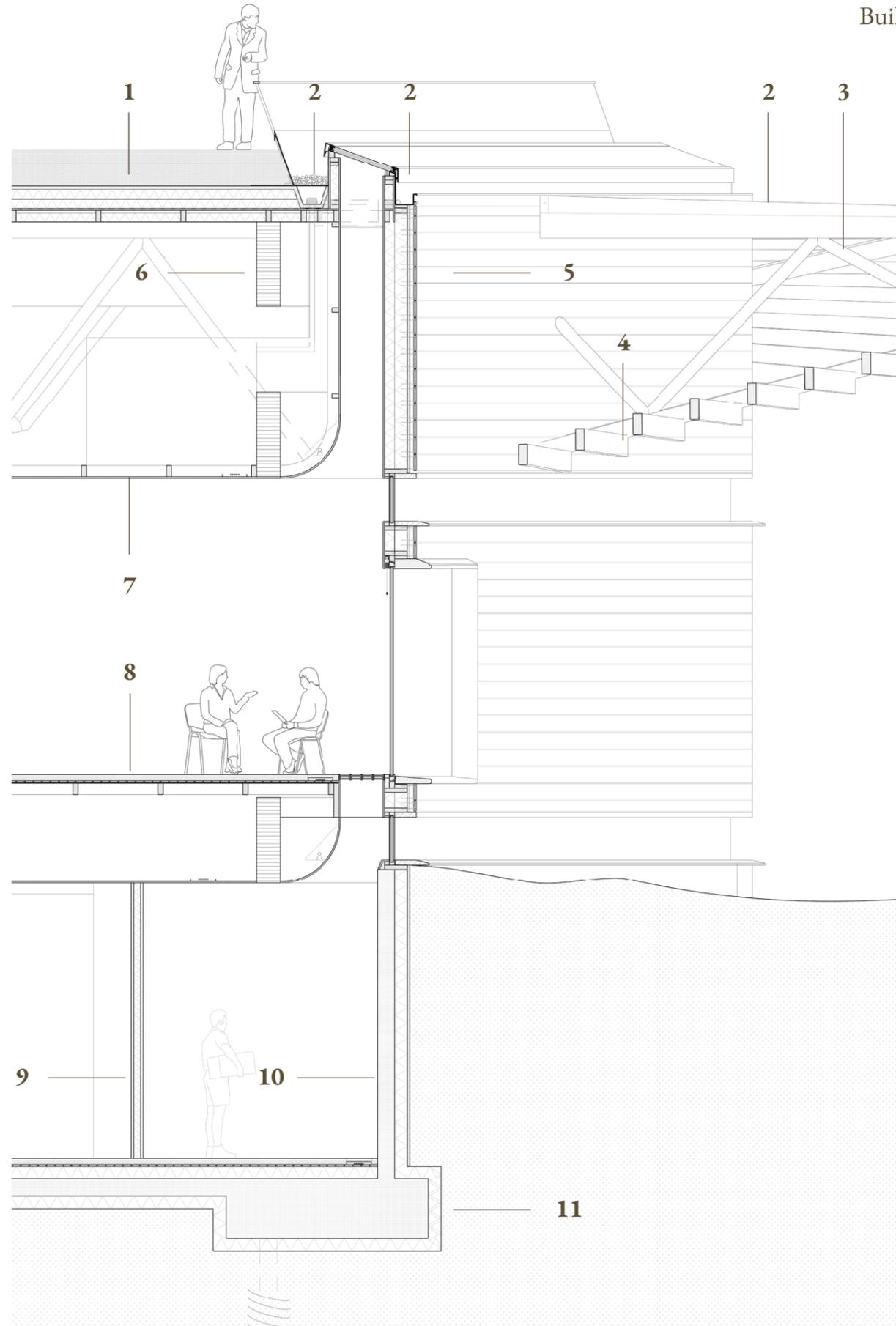
10. retaining wall

- reinforced concrete

11. foundation

- strip pad foundation with screw piles

Building fragment | Scale 1:20 @A1



- 1. roof garden**
 - vegetation layer
 - 430 mm sand
- 2. gutter(s)**
 - for water collection, distribution and draining off the excess
- 3. roof structure**
 - hybrid timber-steel truss
- 4. shading system**
 - fixed timber louvres
- 5. Southern facade cladding**
 - 200mmx30 mm ceramic tiles
 - 50 mm ventilated cavity
- 6. primary structure**
 - 240x1000mm glued laminated timber beam
- 7. ceiling**
 - 18mm timber battens
 - timber studs
- 8. floor**
 - rammed earth with underfloor heating system
- 9. partition wall**
 - timber sandwich panel
- 10. retaining wall**
 - reinforced concrete
- 11. foundation**
 - strip pad foundation with screw piles

1 day

1 year

50 years

100 years

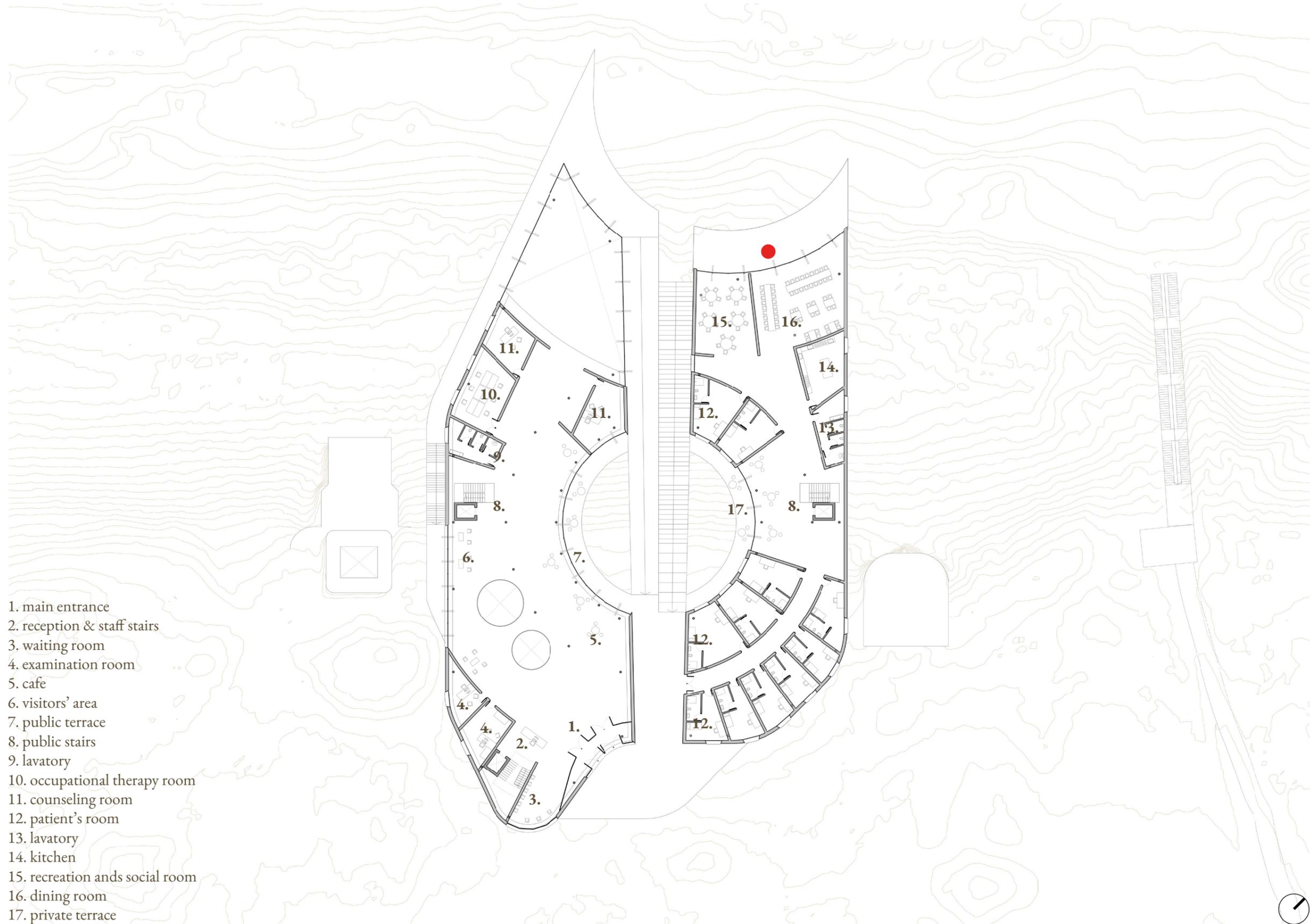
Spring

Summer

Autumn

Winter

Ground floor | Scale 1:200 @A1





1 day

1 year

50 years

100 years

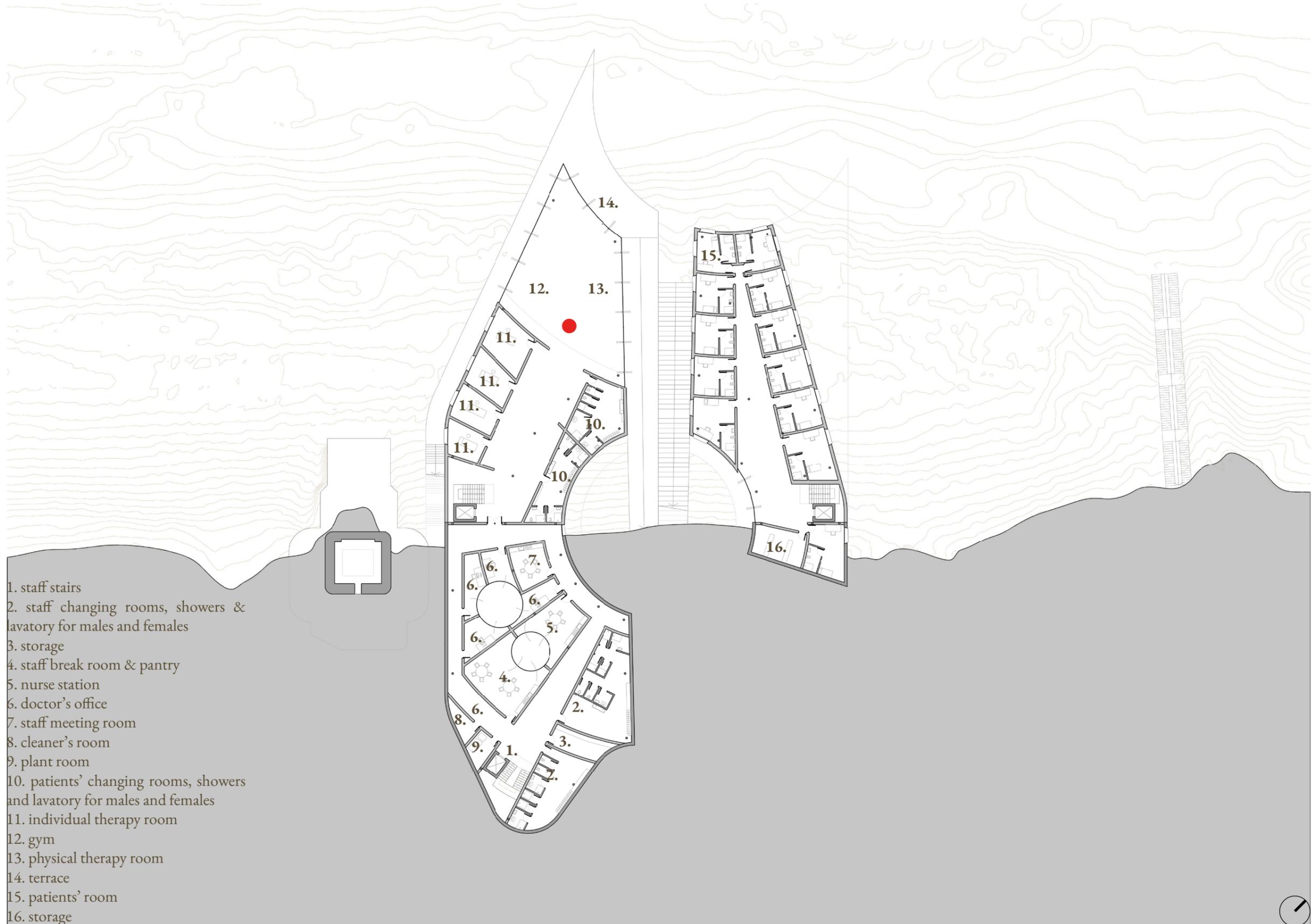
Spring

Summer

Autumn

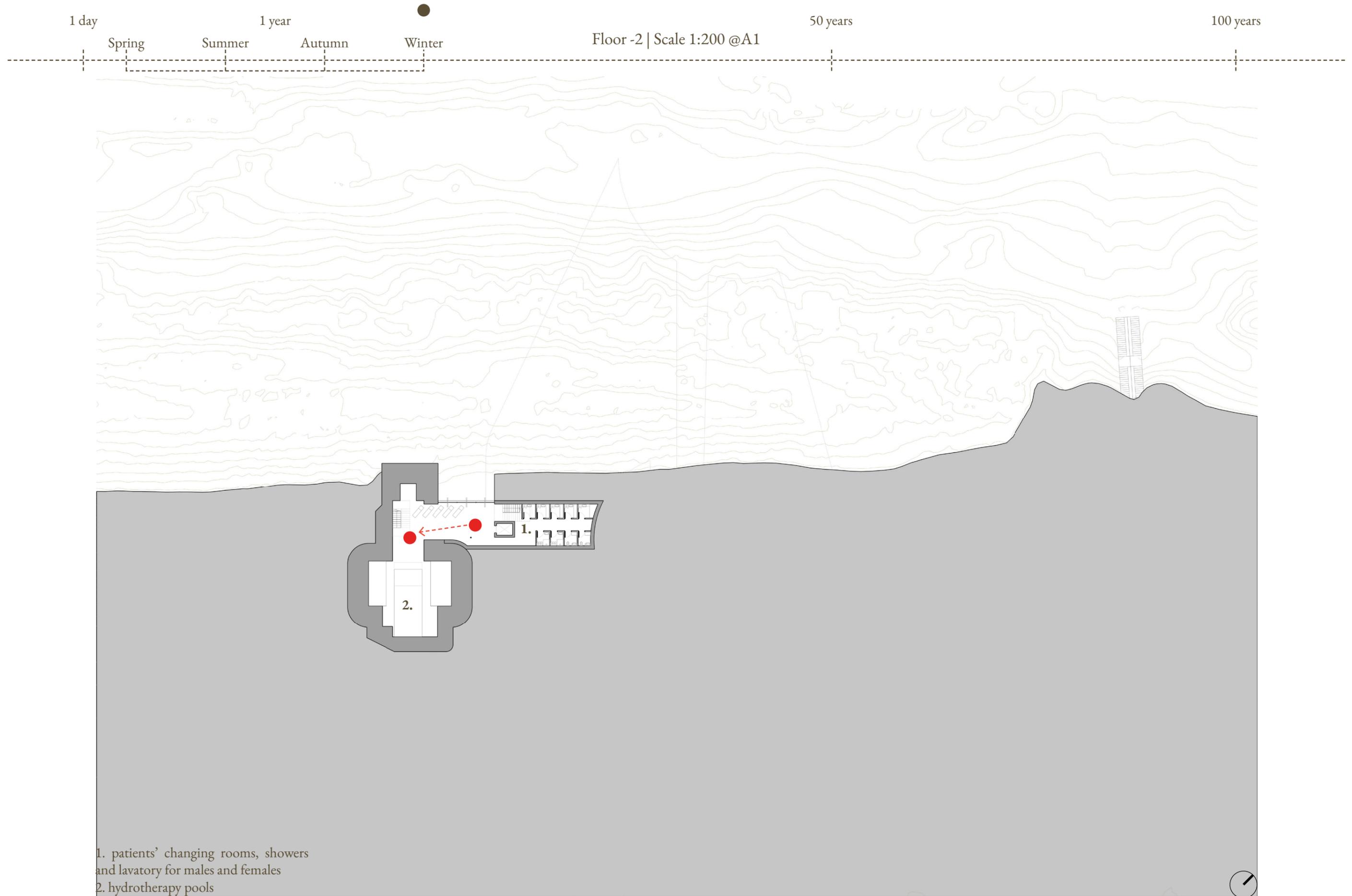
Winter

Floor -1 | Scale 1:200 @A1





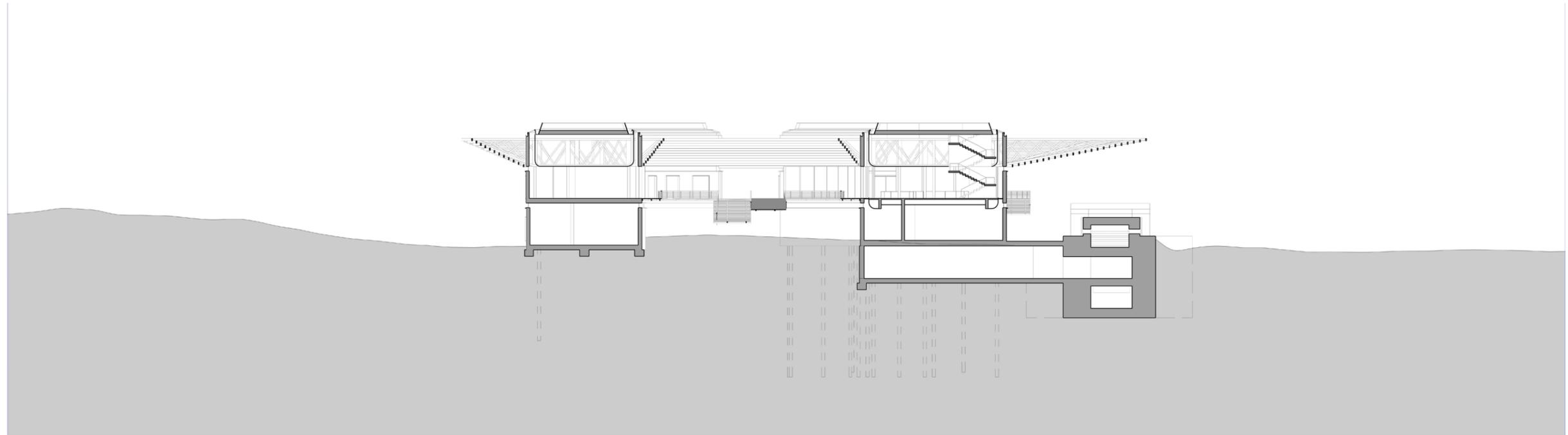
Relationship with the bunker

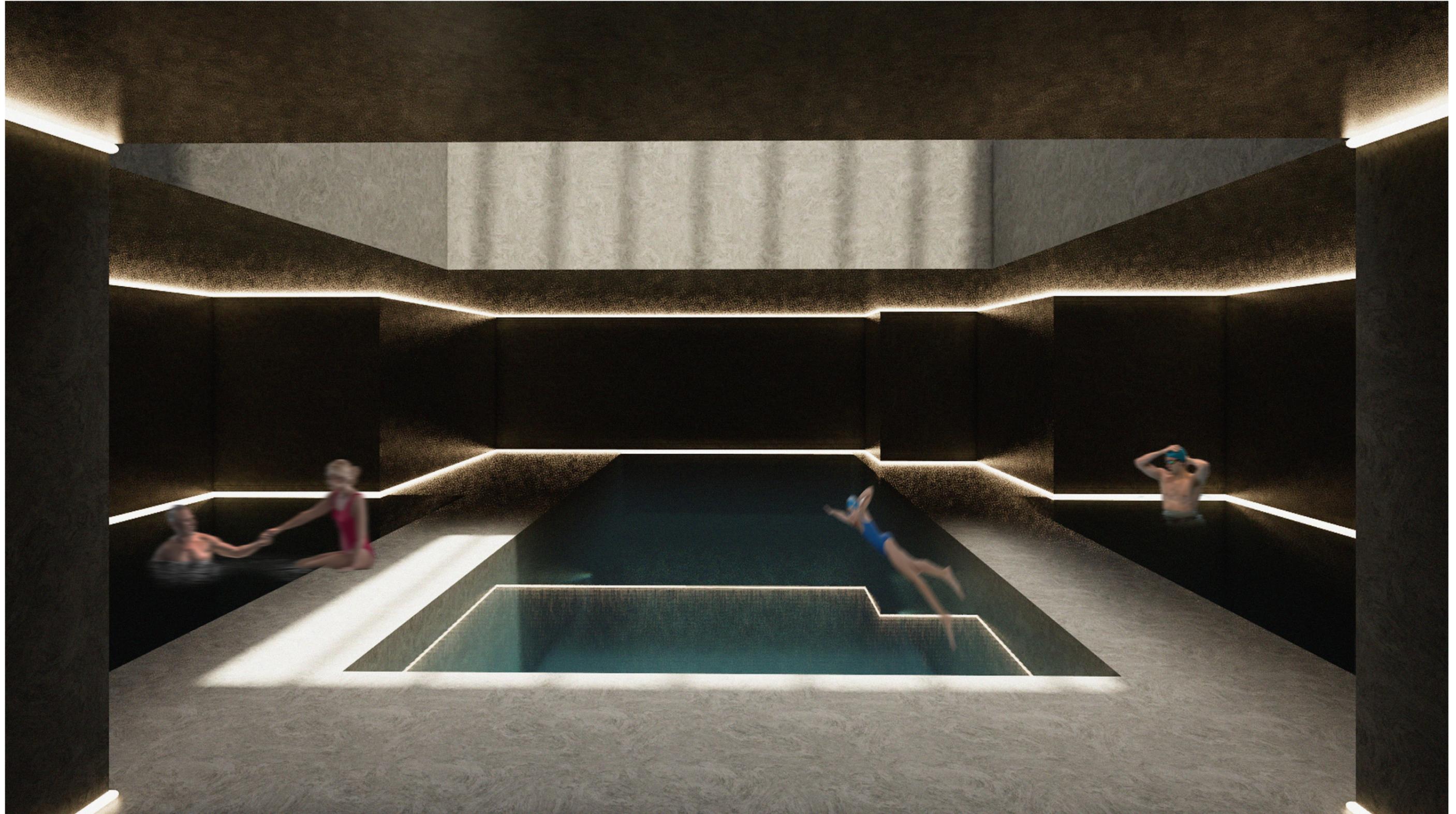
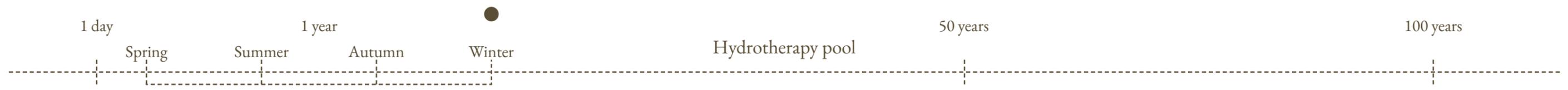


- 1. patients' changing rooms, showers and lavatory for males and females
- 2. hydrotherapy pools

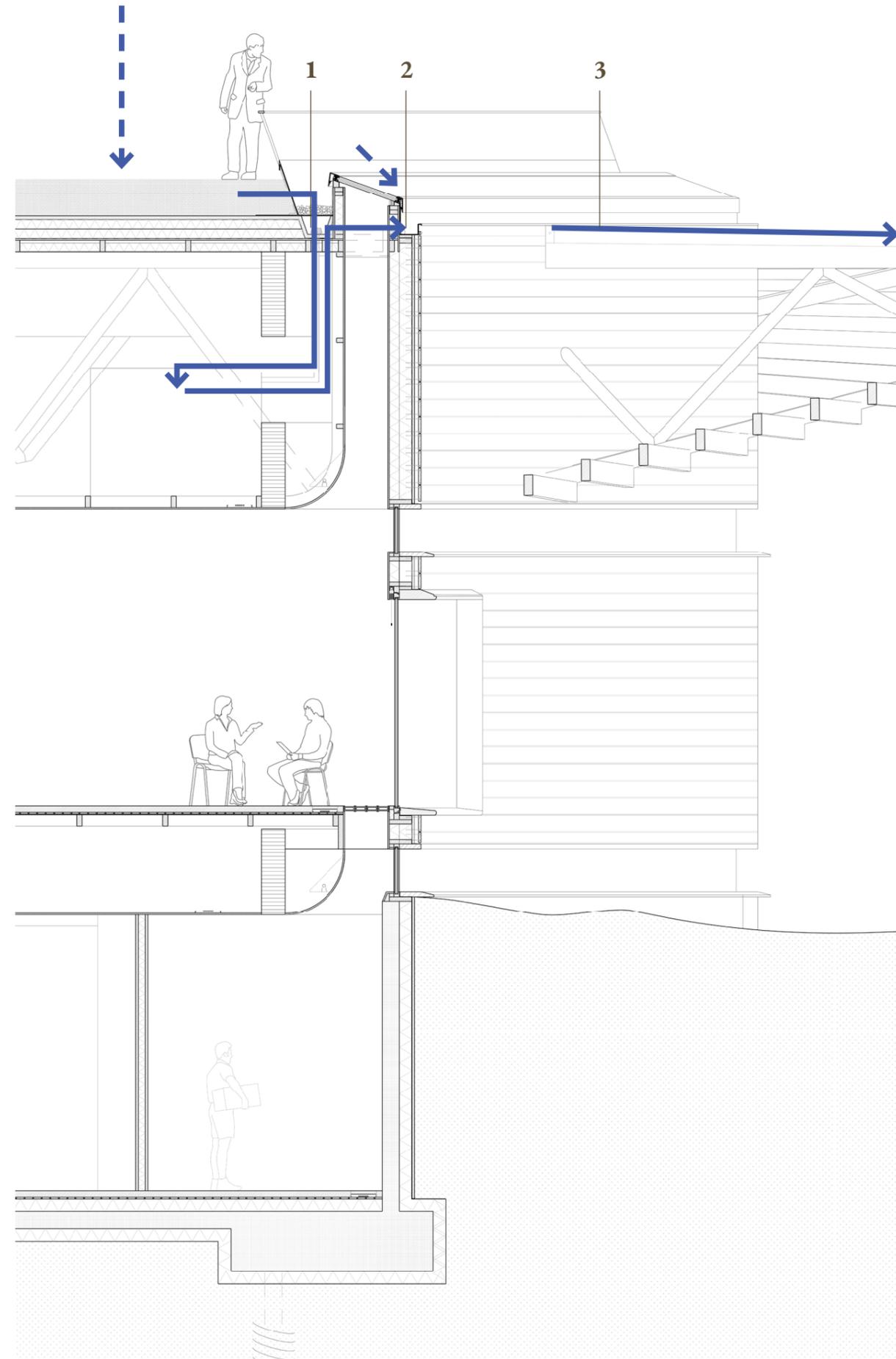


Relationship with the bunker





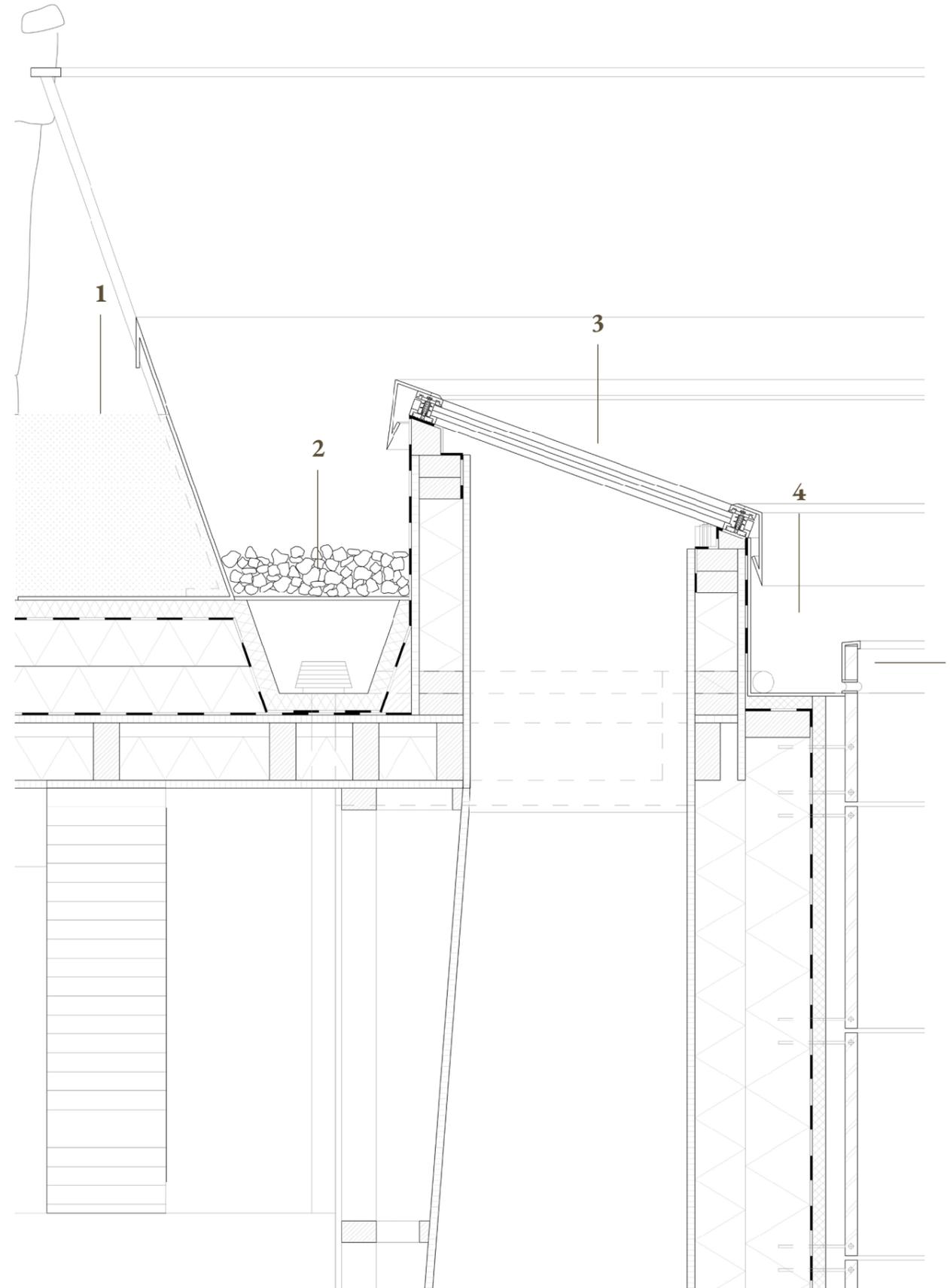
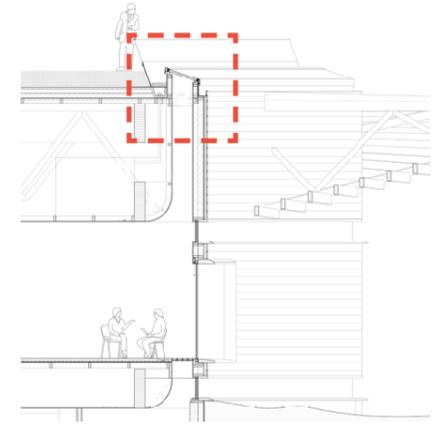
Water distribution on the facade



- 1. rainwater collection
- 2. distribution
- 3. drain off excess water

Water distribution on the facade

Building fragment | Scale 1:5 @A2



1. roof

- vegetation layer
- 430 mm sand
- 40 mm drainage layer
- damp proof membrane
- 2x 110 mm mineral wool thermal insulation
- vapour barrier layer
- 18 mm OSB
- 60x130 mm timber studs
- 100 mm wood fibre insulation
- 18 mm OSB
- 240x1000mm glued laminated timber beam

2. gutter - water collection & storage

- gravel
- filter membrane
- aluminium sheet
- PVC-coated 70mm EPS thermal insulation
- aluminium sheet
- damp proof membrane
- water collection system leading to water storage

3. skylight

- electric opening skylight, laminated safety glass

4. gutter - water distribution

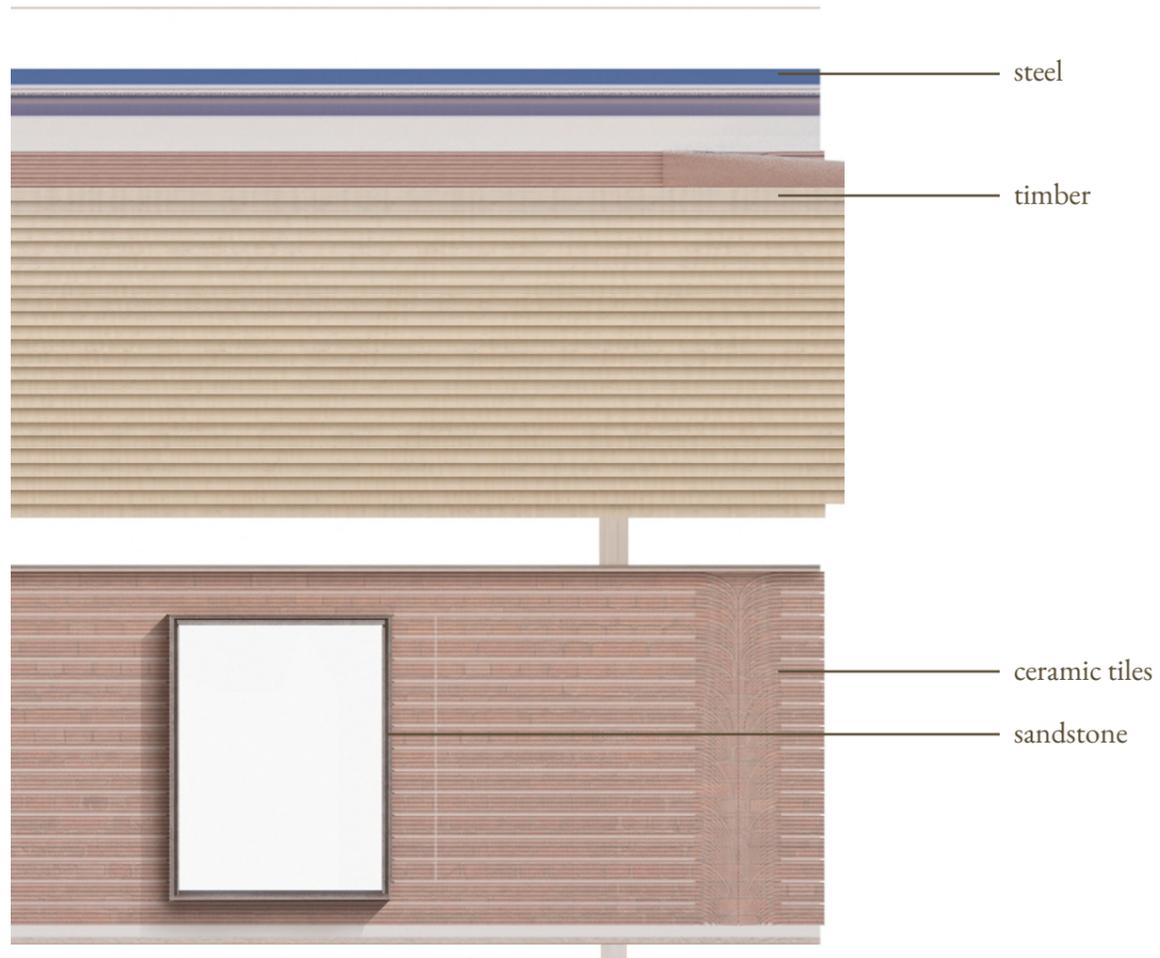
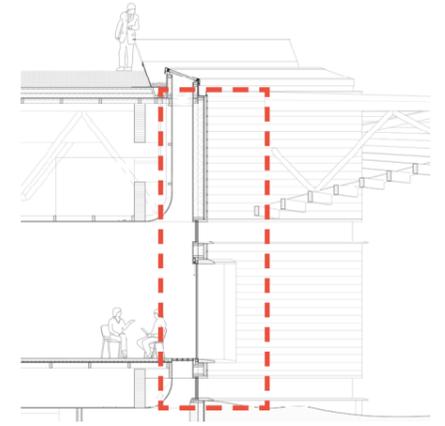
- aluminium sheet
- electric flaps on the sides controlling the amount of water which can reach the facade
- 30 mm mineral wool thermal insulation

5. elevation

- 30 mm bioreceptive concrete tiles
- 50 mm ventilated cavity
- 30 mm mineral wool
- damp proof membrane
- 60x150mm timber posts
- inlaid 150mm wood fibre thermal insulation
- 120 wood fibre insulation
- 18mm OSB

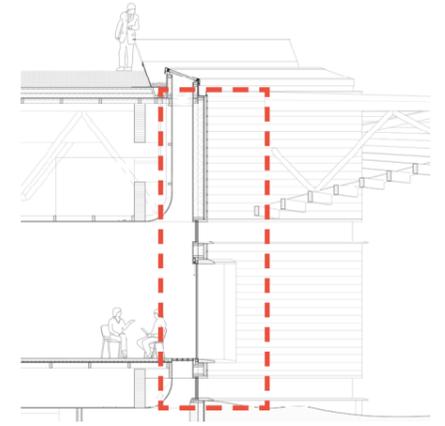
Water distribution on the facade

Materiality and details



Water distribution on the facade

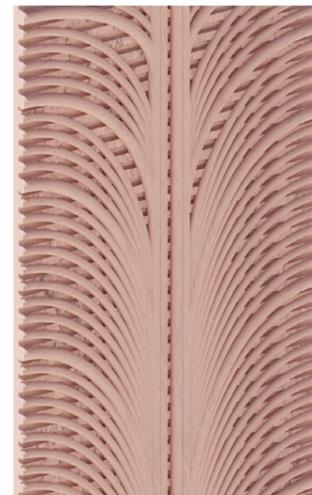
Materiality and details



sandstone window frame with drainage channels



ceramic tile with horizontal channels to retain water

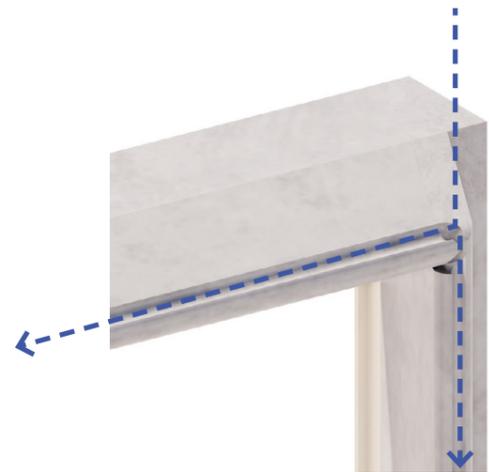
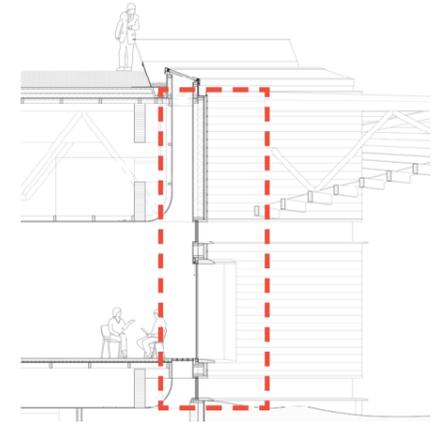


ceramic gutter embedded within the facade

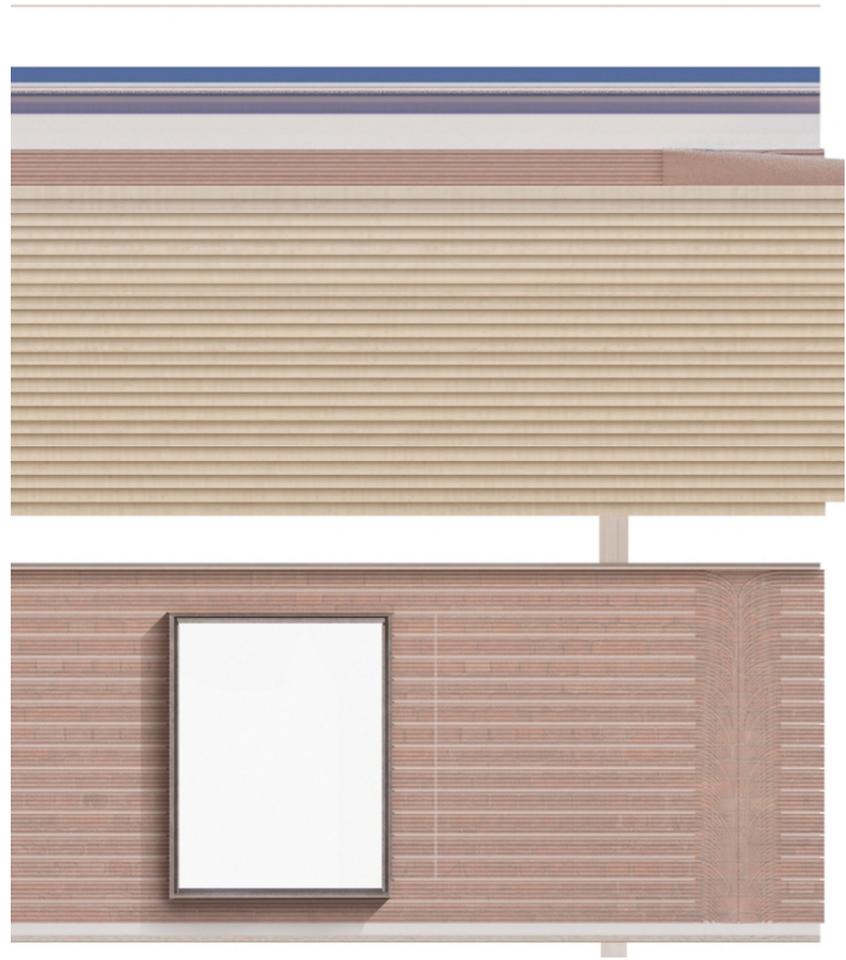


Water distribution on the facade

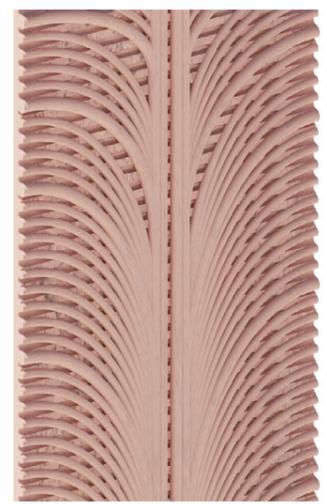
Materiality and details



sandstone window frame with drainage channels

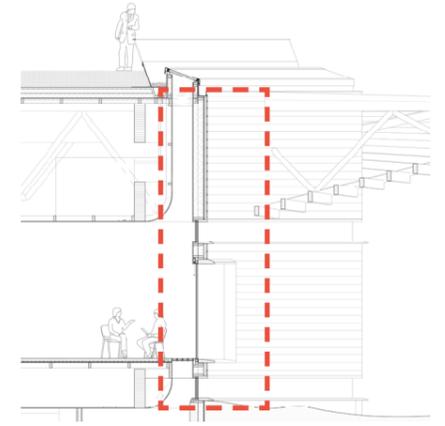


ceramic tile with horizontal channels to retain water

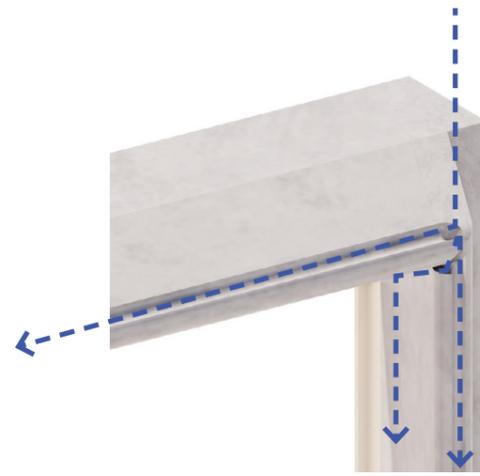


ceramic gutter embedded within the facade

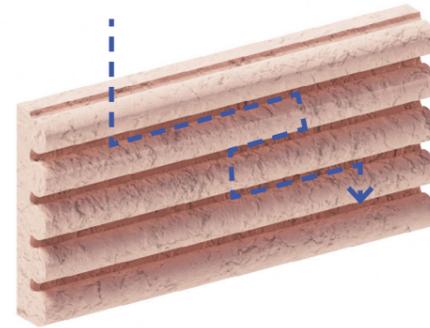
Water distribution on the facade



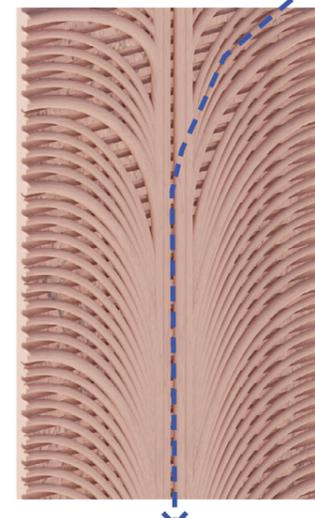
Materiality and details



sandstone window frame with drainage channels



ceramic tile with horizontal channels to retain water



ceramic gutter embedded within the facade



“Controlled“ weathering



"Controlled" weathering

1 day

1 year

50 years

100 years

Spring

Summer

Autumn

Winter



