ADV 9674
Proseminar in ECOLOGIES: Regenerative, Interrelated, Evolving

Dec. 16th, 2025
Teresa Li

Seeing the Invisible Landscape

Translating data, atmosphere, and emotion into responsive landscape design

Challenge

How can we make invisible ecological flows, like heat, wind, moisture, and energy, perceptible and experiential in landscape design?

How can we visualize and feel these hidden interactions to better understand what happens when ecosystems change?

James Corner

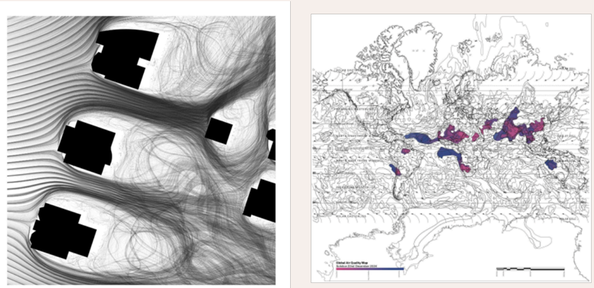
“Not Unlike Life Itself: Landscape Strategy Now” (2014)

_how representation can act as an instrument of understanding, not just depiction.

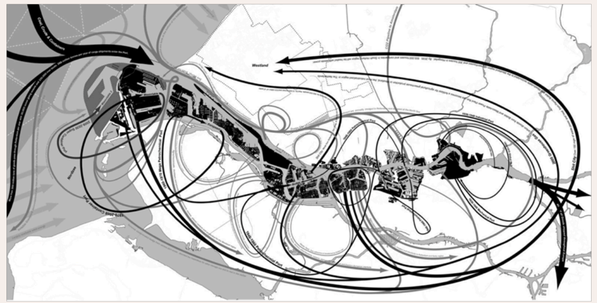
“The Agency of Mapping” (2007)

_mapping as an active method to reveal dynamic relations in landscape.

Setting



Craig Douglas, Digital Air, 2025.



OPSYS / Pierre Bélanger, Waste Flows, Backflows, and Reflows, Maas-Rhine River Delta, Rotterdam, The Netherlands, 2009.

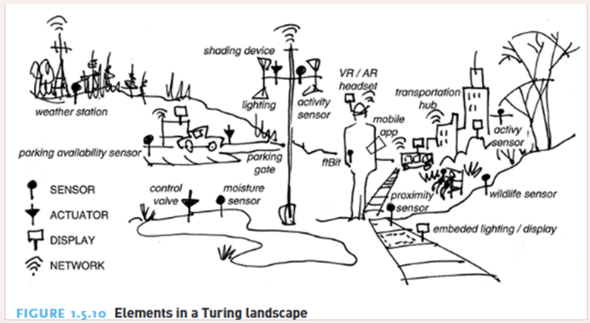


FIGURE 1.5.10 **Elements in a Turing landscape**

Stephen M. Ervin, Turing landscapes, Codify, 2018.

01 CONTEXT

Ecological systems are shaped by invisible flows, heat, wind, moisture, and energy, that we rarely perceive directly.

02 NOW

Landscape design often relies on 2D diagrams, which flatten these dynamic processes and separate data from lived experience.

03 POTENTIAL

How can we visualize and feel these hidden interactions to better understand what happens when ecosystems change?

Intention + Concept

Position the work as connecting digital environmental sensing (scientific data) with affective environmental perception (emotional/atmospheric response).

To develop a visualizing and evaluating tool that translates ecological data into spatial and sensory experience.

The project links environmental data (temperature, humidity, airflow, geospatial info) with emotional and sensory cues–like the “mood” of trees, the comfort of shade, the texture of air, or surrounding built environment.

To promote ecological empathy and responsiveness in the design process.

Conceptual Framework

Key highlights from ***Ecological Empathy***

- has potential as a way to reconnect people to nature by building relationships among more-than-humans.
- consists of two subcomponents: contextual understanding of more-than-human interdependencies and more-than-human awareness and earthy system perspective-taking.
- can be advanced across a range of decision, policy and design environments to address human–nature (re)connection.

Lauren Marie Lambert

“Ecological empathy: relational theory and practice” (2014)

_defined as perspective-taking and recognizing interdependence with the more-than-human world.

Framework Setting

Social Empathy	Ecological Empathy
Contextual Understanding of Systemic Barriers	*Contextual Understanding of **More-than-human Interdependencies***
Macro Self-Other Awareness & Perspective-Taking	***More-than-human Awareness & Earth System Perspective-Taking***

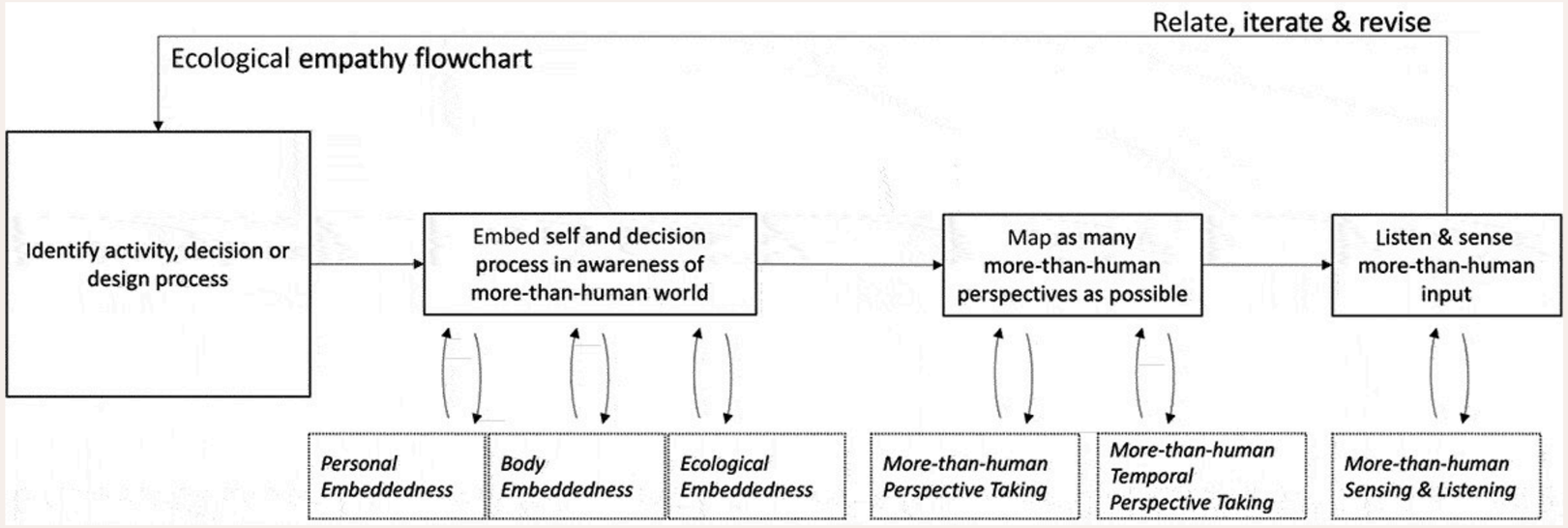
Table 1. Building ecological empathy from social empathy.
Lauren Marie Lambert *"Ecological empathy: relational theory and practice" (2014)*

Embodied Sensory Immersion & System Visualization

Designing perceptual tools that reveal invisible ecological processes and enable users to experience interdependence and system dynamics

Framework Setting

From “Ecological Empathy” Paper

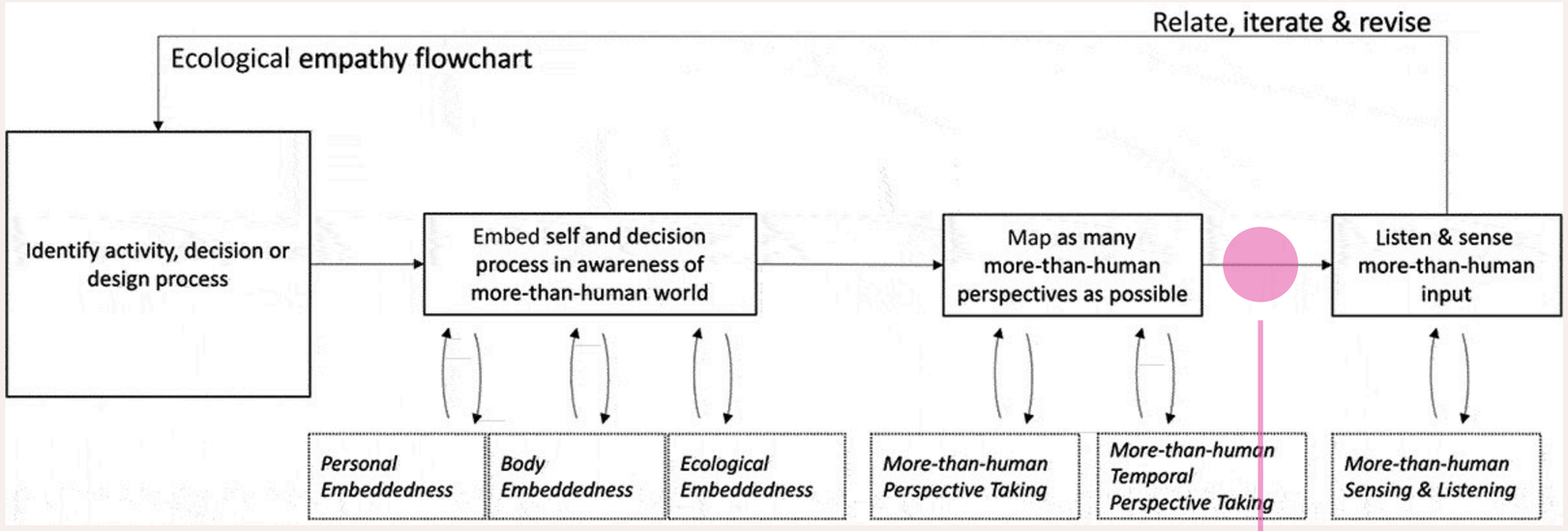


Ecological empathy competence building flowchart: the solid outlines circumscribe processes for building ecological empathy, while the dotted outlines circumscribe the ecological empathy sub competences that get built in each process step.

Lambert, Lauren Marie. 2024. “Ecological Empathy: Relational Theory and Practice.” Ecosystems and People 20 (1). doi:10.1080/26395916.2024.2396919.

Framework Setting

From “Ecological Empathy” Paper



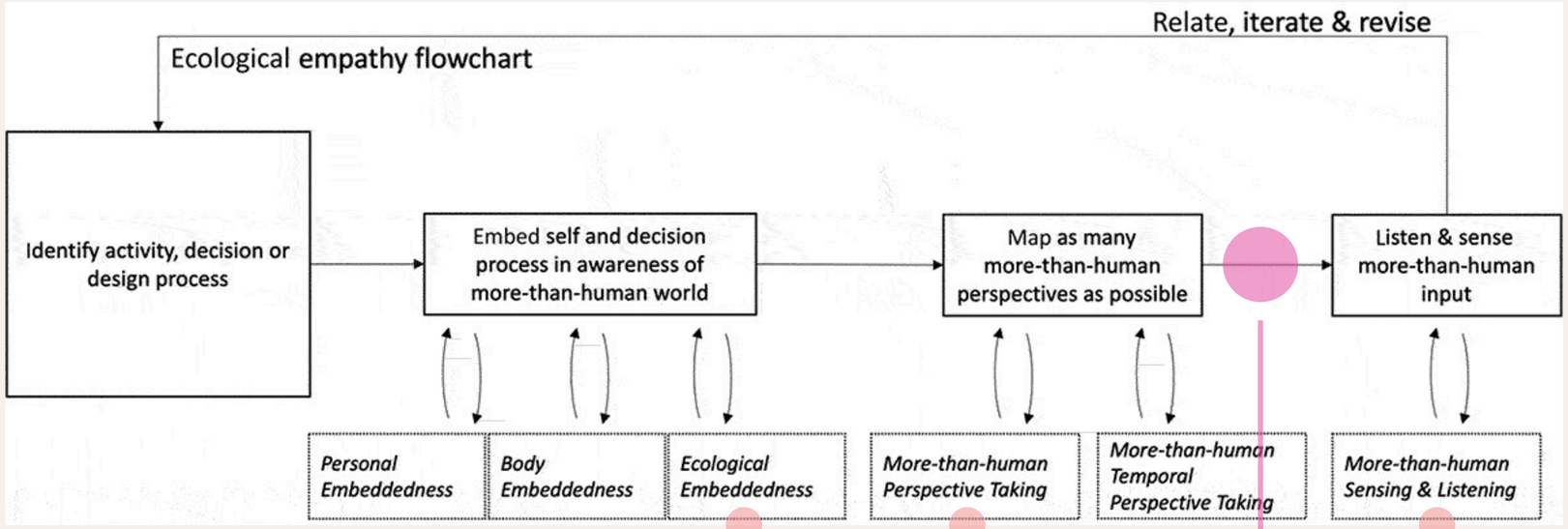
My project perspective

Design immersive experience to spatialize more-than-human processes

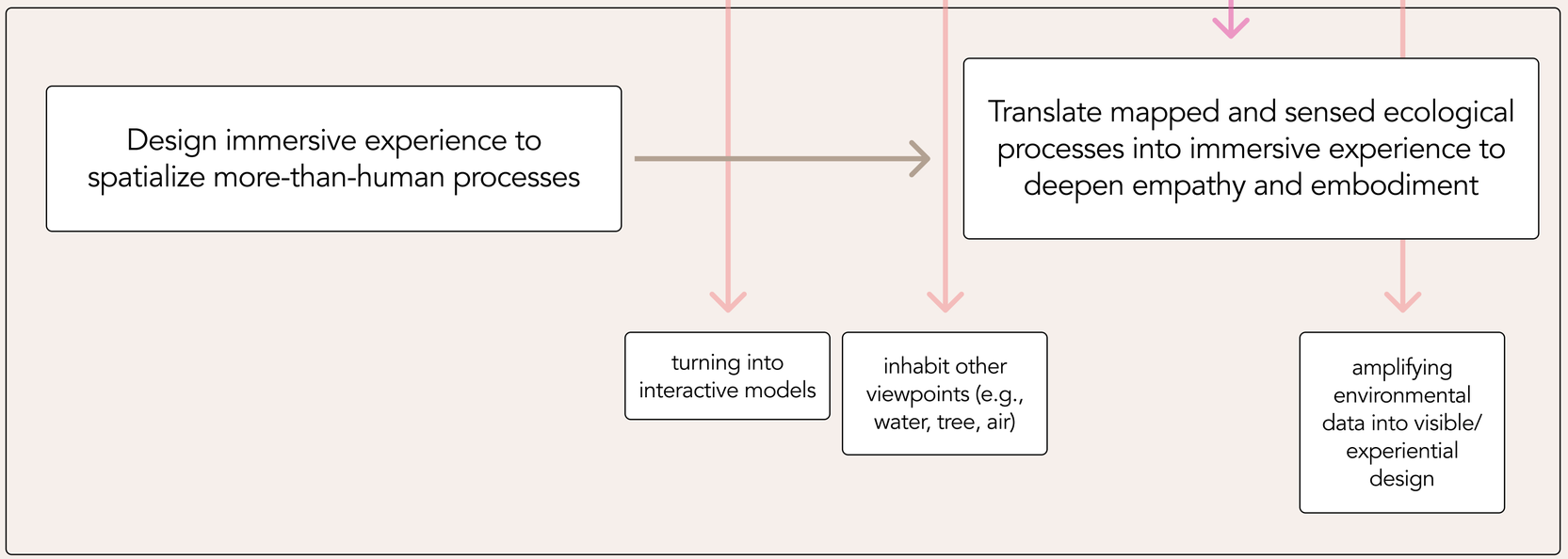
Translate mapped and sensed ecological processes into immersive experience to deepen empathy and embodiment

Framework Setting

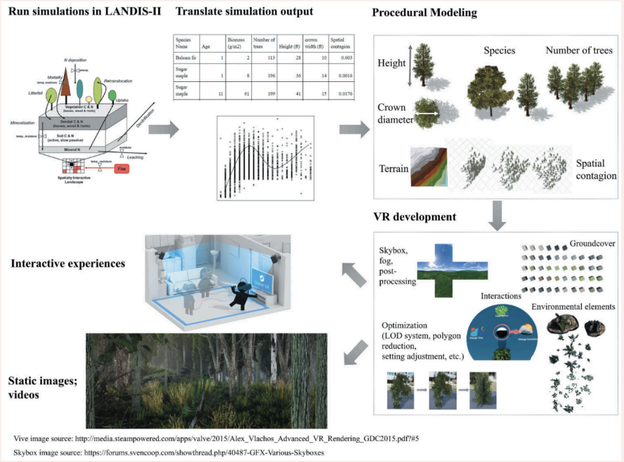
From “Ecological Empathy” Paper



My project perspective



Framework Setting



A user exploring how specific species (such as red pine) responds to climate change.

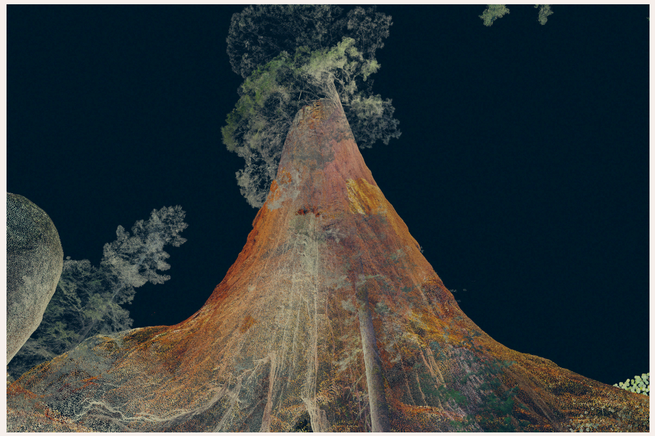
The user selects basswood to view how this species reacts to climate change.

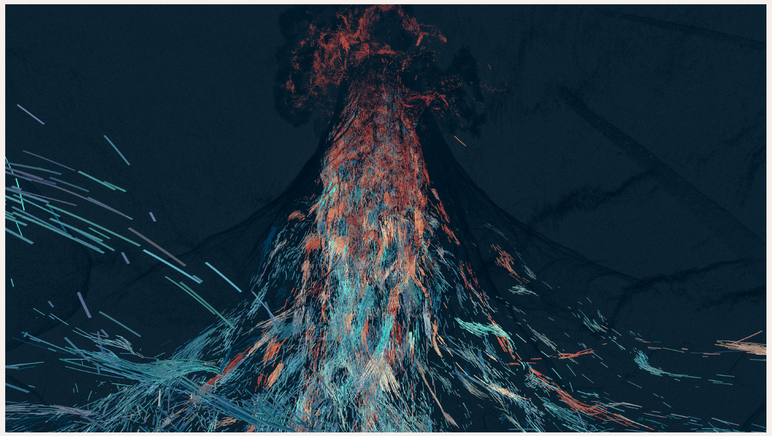
The paper investigates how data-driven virtual reality (VR) can be used to make future ecological change

- shows strong potential for decision-making support, public engagement, and interdisciplinary communication, particularly around climate change.
- Immersive, data-driven VR enhances intuitive understanding of complex ecological processes

Walking through the forests of the future: using data-driven virtual reality to visualize forests under climate change" (Huang et al., International Journal of Geographical Information Science, 2021)

Framework Setting





The project Treehugger: Wawona is key precedent.

- uses techniques visualize a tree's internal flows like water and respiration, making the invisible perceptible.
- immersive design can shift perception and build emotional connection to ecological systems.

Marshmallow Laser Feast (2017). Treehugger: Wawona – VR installation. (Immersive project visualizing a sequoia's inner life to inspire empathy and awe)fabbula.com

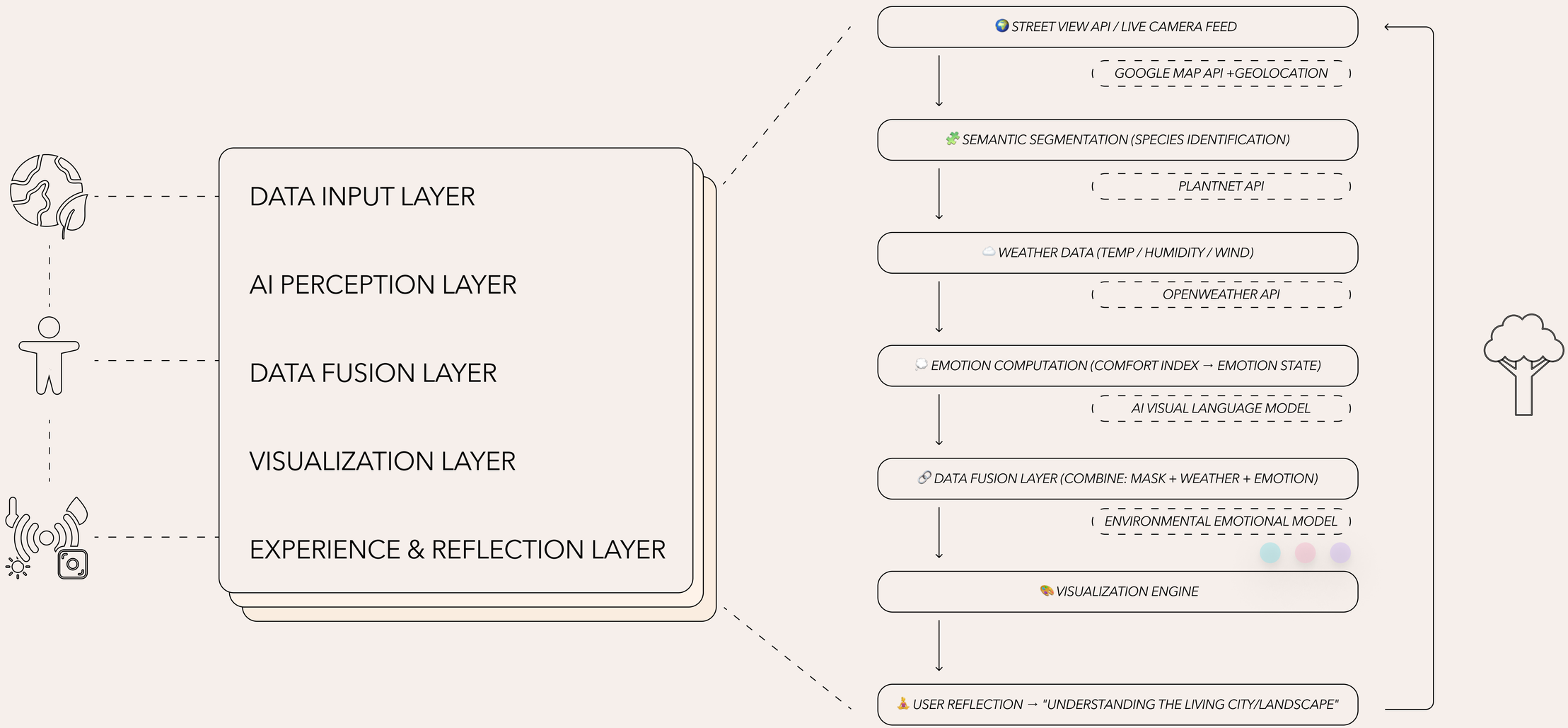
Tools

01 REVEAL	Research on existing techniques and related projects innovation	Data collection
02 CODIFY	Simulation and Visualization for immersive translation	3D representational modes
03 EVALUATE	Evaluate environmental flows at multiple scales	Ecological sensing interface Web / AR

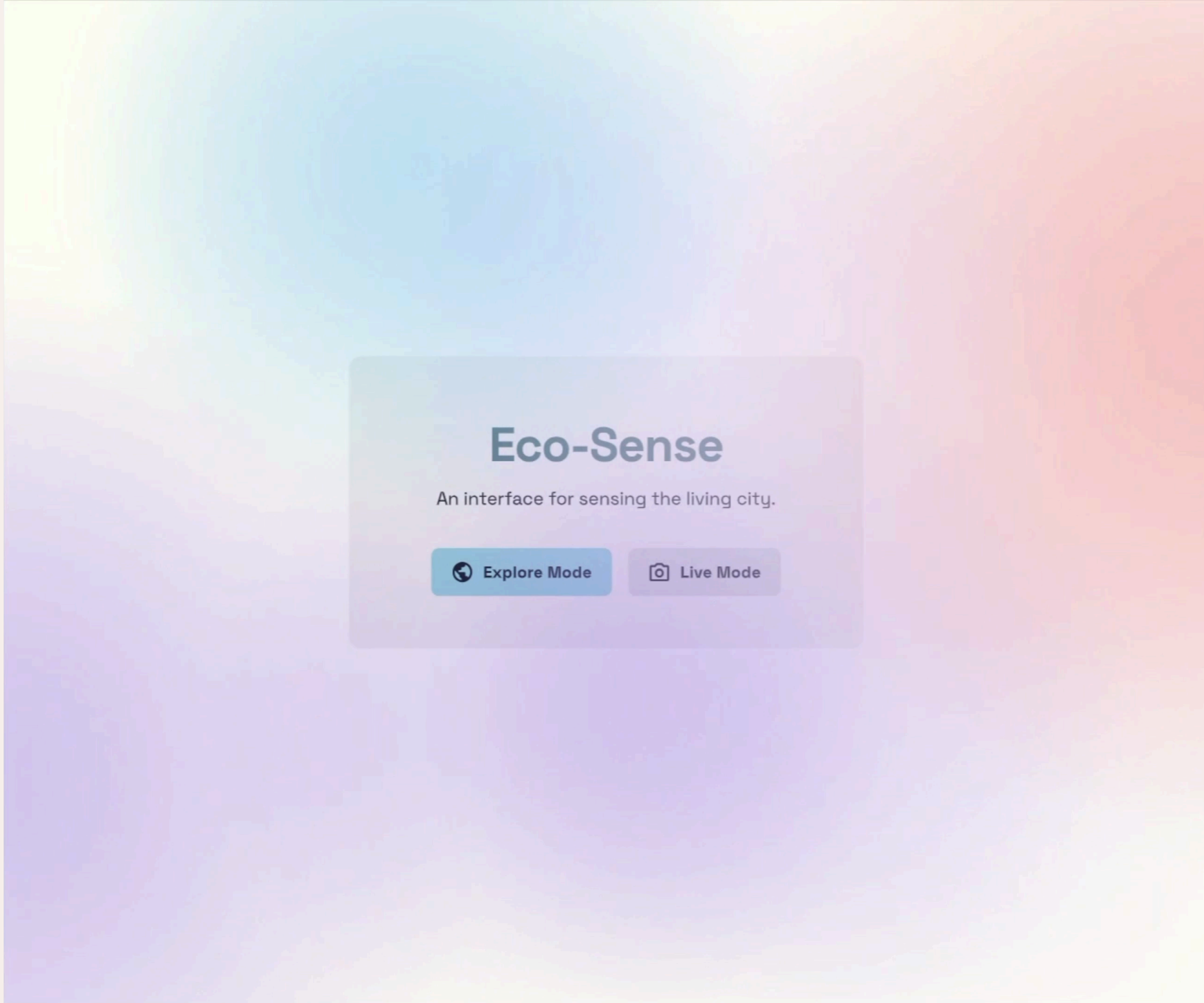
Actors

NONHUMAN ACTORS	trees, air, soil microbes, etc., as sensing entities. 
HUMAN ACTORS	designers, users, citizens interacting with the environment. 
TECHNOLOGICAL MEDIATORS	sensors, data visualization systems, XR interfaces. 

Actors


DATA INPUT LAYER
AI PERCEPTION LAYER
DATA FUSION LAYER
VISUALIZATION LAYER
EXPERIENCE & REFLECTION LAYER
🌍 STREET VIEW API / LIVE CAMERA FEED
GOOGLE MAP API +GEOLOCATION
🧩 SEMANTIC SEGMENTATION (SPECIES IDENTIFICATION)
PLANTNET API
☁️ WEATHER DATA (TEMP / HUMIDITY / WIND)
OPENWEATHER API
💭 EMOTION COMPUTATION (COMFORT INDEX → EMOTION STATE)
AI VISUAL LANGUAGE MODEL
🔗 DATA FUSION LAYER (COMBINE: MASK + WEATHER + EMOTION)
ENVIRONMENTAL EMOTIONAL MODEL
🎨 VISUALIZATION ENGINE
🙏 USER REFLECTION → "UNDERSTANDING THE LIVING CITY/LANDSCAPE"

Initial Interface Prototype



Metrics

EMOTION COMPUTATION (COMFORT INDEX → EMOTION STATE)

Common Tree Species in Boston and Their Features

Species	Temp (°C)	Humidity (%)	Light	Drought Tolerance	Pollution Tolerance	Emotional States
Red Maple	15–27 optimal, >35 stress, >40 critical	50–80 preferred, <30 low	Medium–High	Low	Low–Medium	Tired, Calm, Anxious
Ginkgo	15–30 optimal, >38 stress, >45 critical	40–70 preferred, <20 low	High	High	High	Content, Overheated
London Plane	20–30 optimal, >35 stress, >40 critical	40–80 preferred, <25 low	High	High	High	Healthy, Scorched
Honey Locust	20–35 optimal, >40 stress, >45 critical	30–60 preferred, <15 low	High	Very High	Very High	Thriving, Surviving
Pin Oak	15–28 optimal, >33 stress, >38 critical	50–90 preferred, <40 low	High	Low	Medium	Balanced, Withering
Littleleaf Linden	18–26 optimal, >32 stress, >35 critical	60–85 preferred, <40 low	Medium	Moderate	High	Flourishing, Exhausted

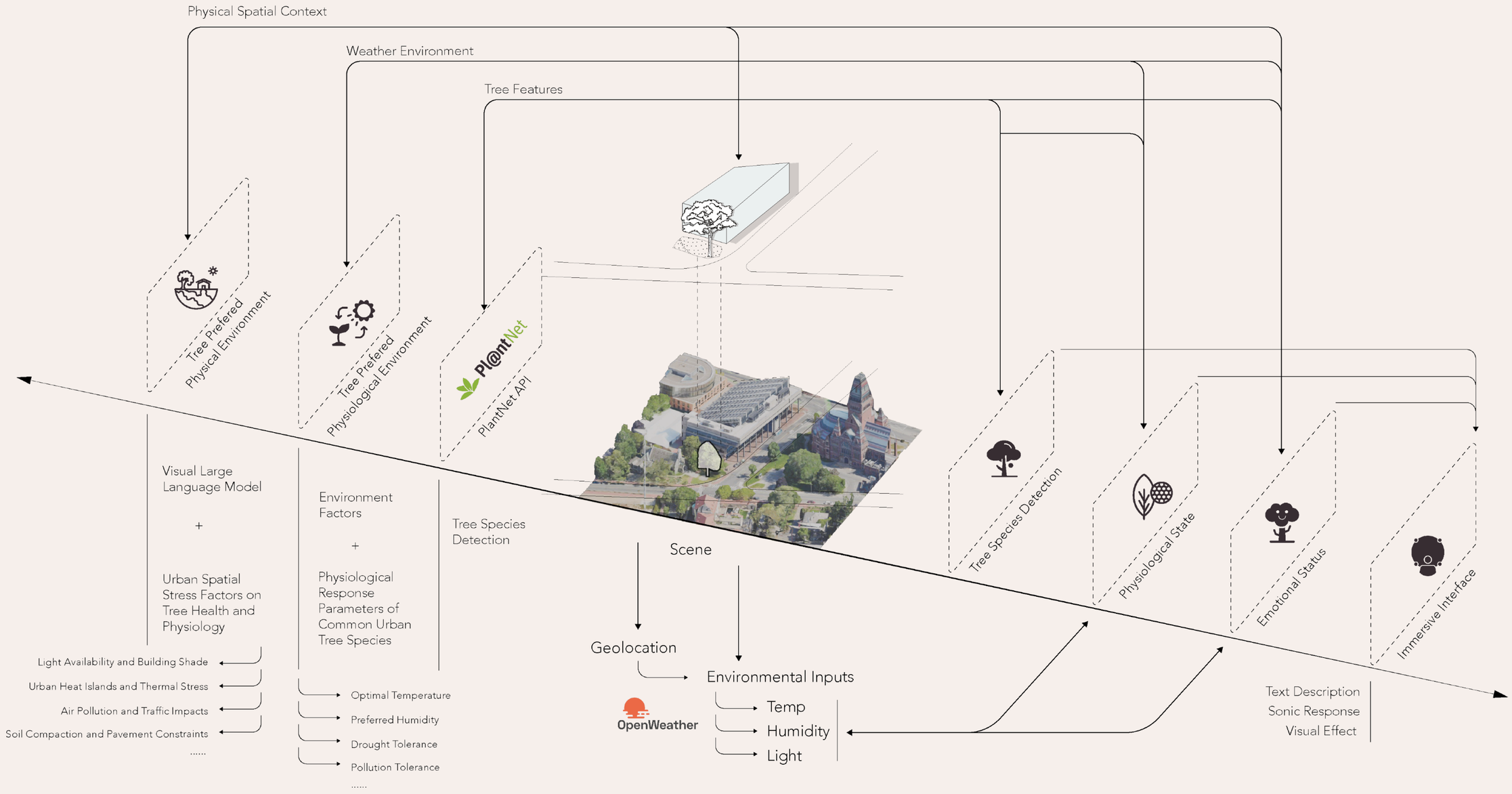
Metrics

EMOTION COMPUTATION (COMFORT INDEX → EMOTION STATE)

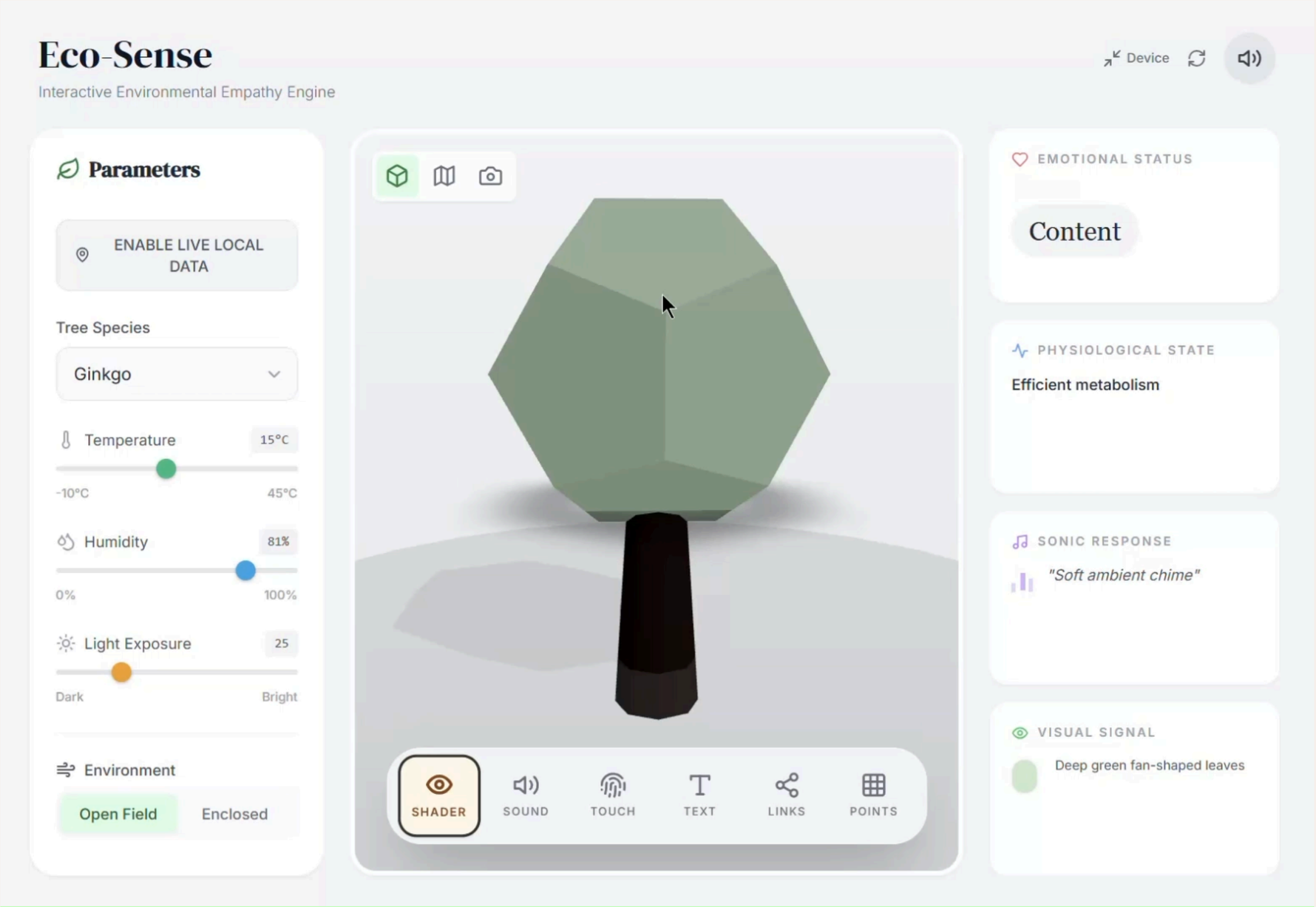
Urban Spatial Stress Factors on Tree Health and Physiology

Stress Factor	Spatial Feature Detected	Physiological Impact	Emotional Model Cue
Building Shade / Light Block	Tall buildings nearby, narrow streets	Reduced photosynthesis, sparse canopy	Low energy / Stretching for light
Urban Heat Island (UHI)	Asphalt surface, enclosed space, low canopy	Overheating, high transpiration, water stress	Anxious / Heat exhaustion
Wind Exposure (Wind Tunnels)	Between tall buildings, open intersections	Accelerated water loss, branch sway	Strained / Wind-stressed
Soil Compaction / Paved Pit	Street pit planting, sidewalk box	Restricted root growth, low water/nutrient uptake	Tense / Underpowered
Air Pollution (Ozone, NO_2)	Roadside / vehicle corridor	Stomatal damage, photosynthesis decline	Sick / Irritated
Particulate Dust Accumulation	Construction zone / traffic-heavy area	Stomatal blockage, overheating, leaf scorch	Choked / Gasping

System Flow

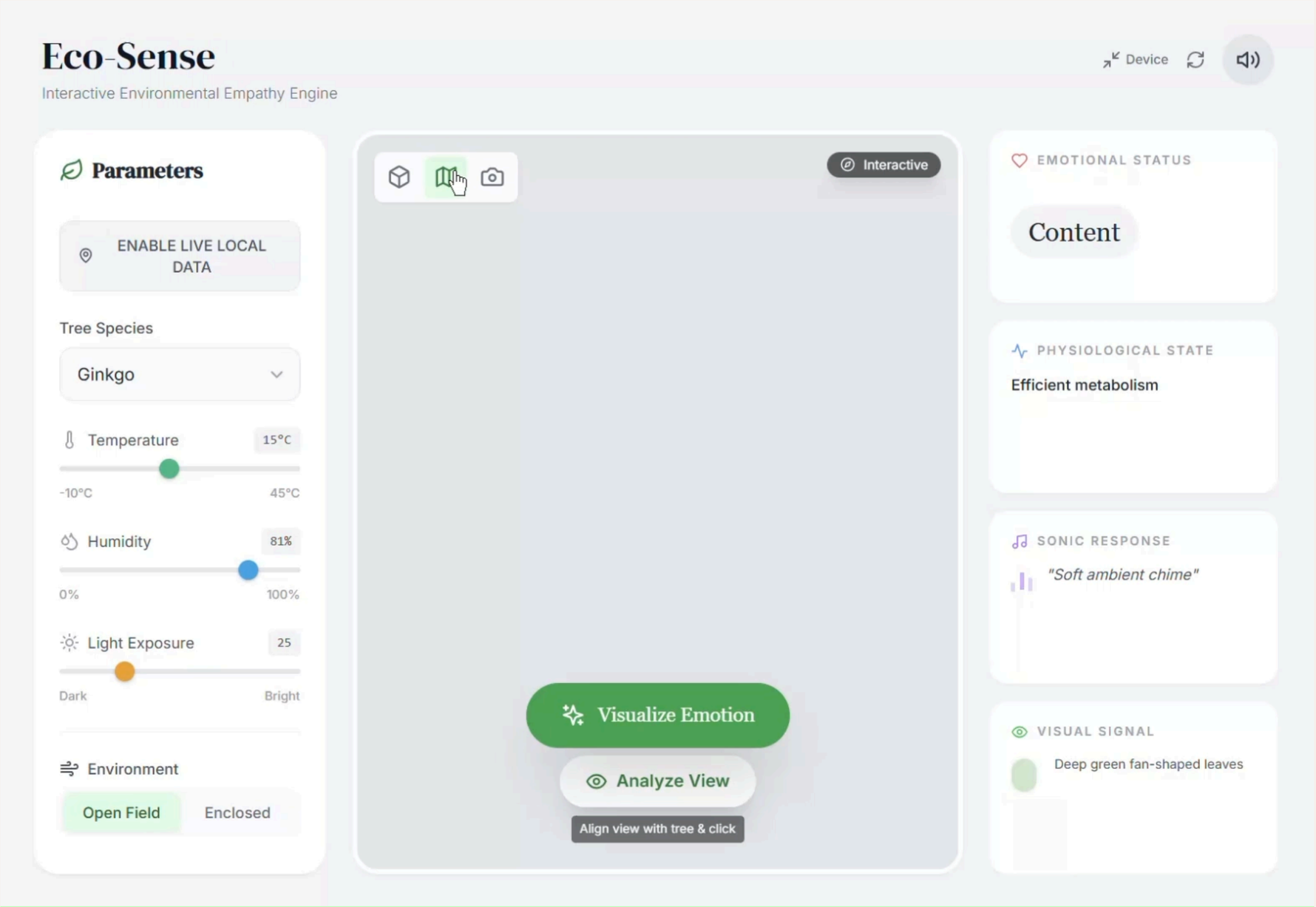

Physical Spatial Context
Weather Environment
Tree Features
Tree Prefered Physical Environment
Tree Prefered Physiological Environment
PlantNet API
Visual Large Language Model
+
Urban Spatial Stress Factors on Tree Health and Physiology
Light Availability and Building Shade
Urban Heat Islands and Thermal Stress
Air Pollution and Traffic Impacts
Soil Compaction and Pavement Constraints
.....
Environment Factors
+
Physiological Response Parameters of Common Urban Tree Species
Optimal Temperature
Preferred Humidity
Drought Tolerance
Pollution Tolerance
.....
Tree Species Detection
Scene
Geolocation
OpenWeather
Environmental Inputs
Temp
Humidity
Light
Tree Species Detection
Physiological State
Emotional Status
Immersive Interface
Text Description
Sonic Response
Visual Effect
BACKEND
INTERFACE
FRONTEND

System Prototype



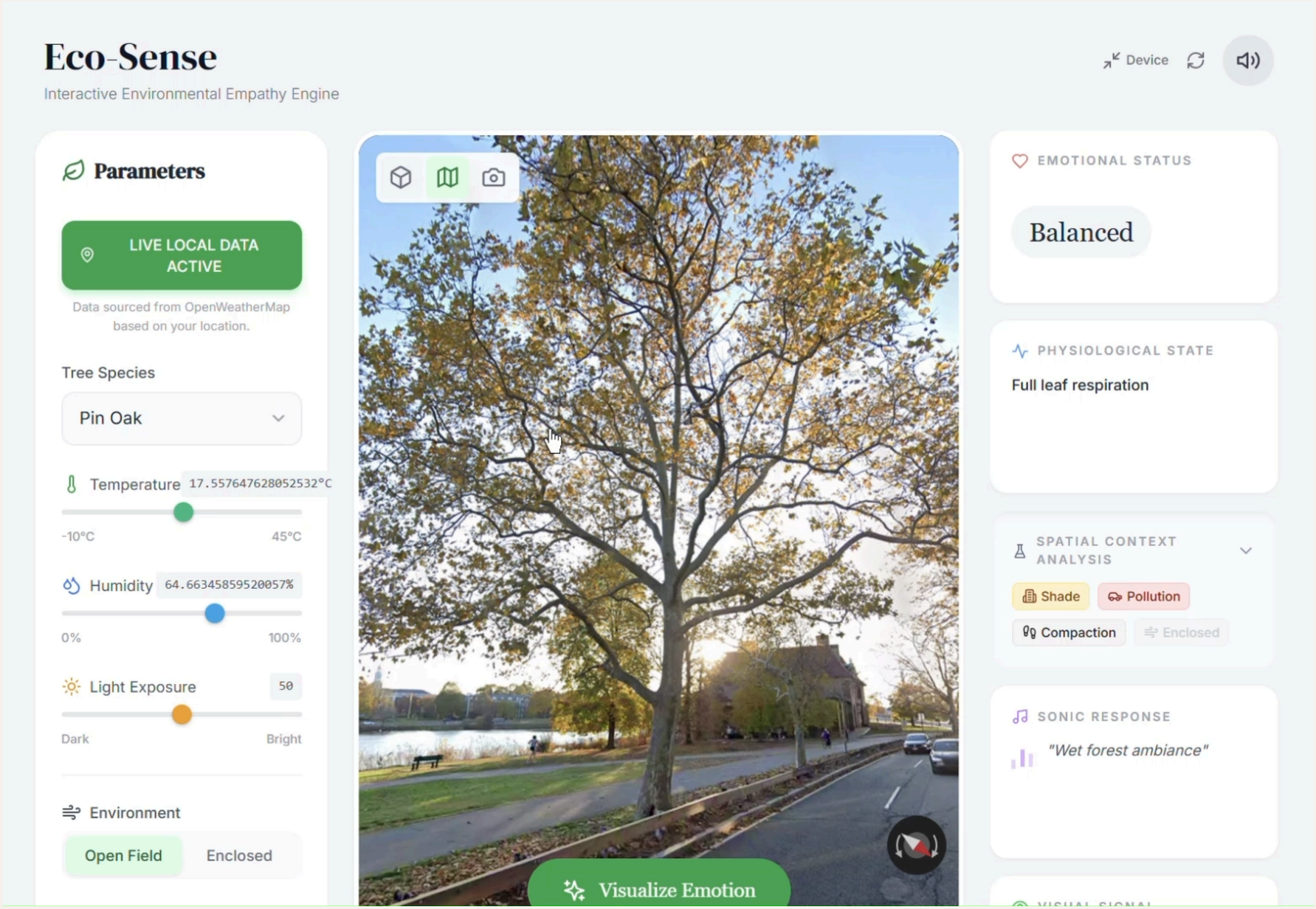
Data Input → Analysis → Visualization

System Prototype



Data Input → **Analysis** → Visualization

System Prototype



Data Input → Analysis → **Visualization**

Future Work

- Real Sensor Integration
  - soil pH, transpiration rate, leaf turgor sensors
- Community
  - archived empathy mapping
  - user collected emotion forests
- AR/MR Overlays in Urban Streetscapes
  - immersive experience and visualized tree moods in real-time space

Reference

Lambert, Lauren Marie. 2024. “Ecological Empathy: Relational Theory and Practice.” *Ecosystems and People* 20 (1). doi:10.1080/26395916.2024.2396919.

Huang, Jiawei, Melissa S. Lucash, Robert M. Scheller, and Alexander Klippel. 2021. “Walking through the Forests of the Future: Using Data-Driven Virtual Reality to Visualize Forests under Climate Change.” International Journal of Geographical Information Science 35 (6): 1155–78. doi:10.1080/13658816.2020.1830997.

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Marshmallow Laser Feast (2017). Treehugger: Wawona – VR installation. (Immersive project visualizing a sequoia’s inner life to inspire empathy and awe)fabbula.comfabbula.com.

Reference

Trees

Red Maple (Acer rubrum)

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- Arbor Day Foundation – Tree Guide
- Walters & Yawney, Red Maple Silvics
- Sibley et al., Root Membrane Thermostability

Ginkgo (Ginkgo biloba)

- Arbor Day Foundation – Tree Guide
- Missouri Botanical Garden
- Ginkgo stress physiology studies (Zhang et al., 2022)

London Plane (Platanus × acerifolia)

- USDA Fact Sheets
- Morton Arboretum – Plant Profiles
- IFAS Extension Reports

Honey Locust (Gleditsia triacanthos)

- Silvics of North America
- Gardenia & Missouri Botanical
- Urban Forestry Notes, Missouri Extension

Pin Oak (Quercus palustris)

- Stratham Nursery – Pin Oak description
- NC State Extension
- Falls Church Urban Forest Plan

Littleleaf Linden (Tilia cordata)

- Missouri Botanical Garden
- Boone County Arboretum
- USDA Plant Fact Sheets

Microclimate Spatial Stressors

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Thanks!