

# Soil Habitability



## From Design Concept to Systemic Integration

*Let's move beyond viewing soil as just dirt or data, and start seeing it as a home*



Earthworms in habitat



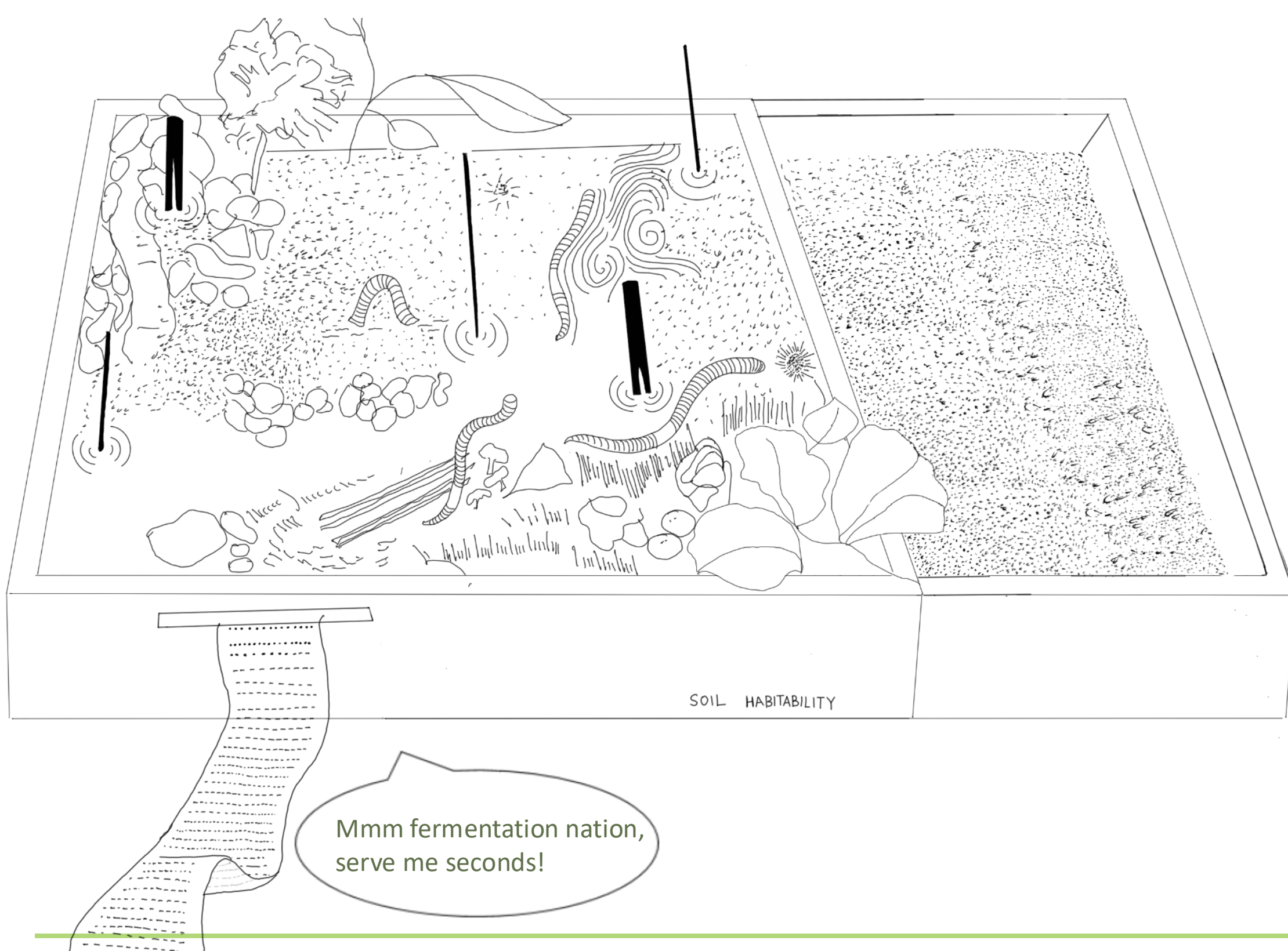
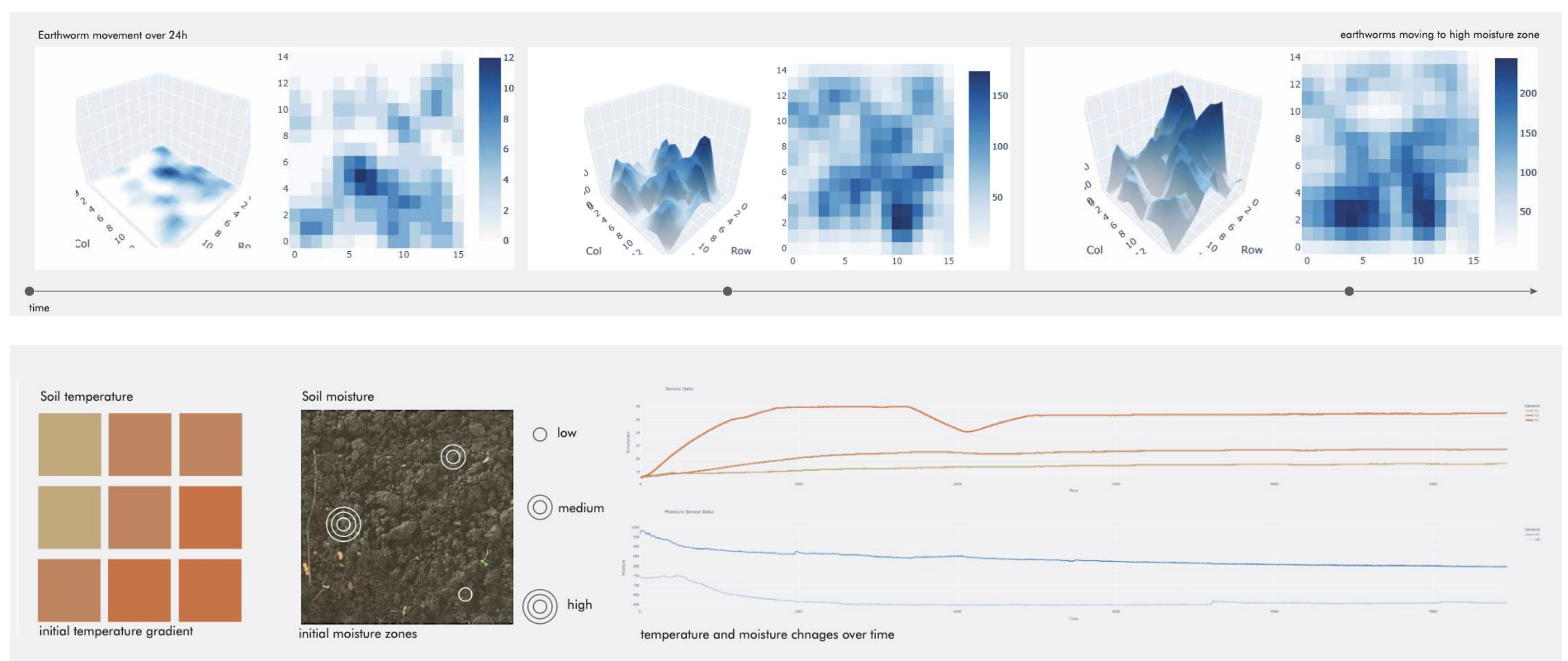
Sensory mat to track motion



Sensor integrated setup

The sensor network combines a custom pressure-sensitive mat, temperature probes, and moisture sensors to capture interrelated variables shaping earthworm behavior. Together, they allow for real-time tracking of environmental shifts while enabling the interpretation of soil not as inert matter, but as an **active multispecies habitat**.

A custom-built data dashboard visualizes real-time and historical data collected from the sensors. It enables exploration of temperature, moisture, and motion patterns over time through interactive heatmaps and temporal graphs. This interface supports pattern recognition, comparative analysis across conditions, and deeper understanding of soil habitability dynamics as they unfold.



Data is translated into speculative messages printed voiced from the earthworms' imagined perspective. This intervention reconfigured sensor data from a system of measurement into a **relational and expressive medium**, inviting humans to notice, interpret, and engage with soil life affectively. These messages fostered **interpretive ambiguity**, supporting attunement to multispecies presence and shifting data from a tool of control to a site of **ethical encounter and world-making**. The approach demonstrates how speculative framing can open new modes of sensing-with, rather than sensing-for.



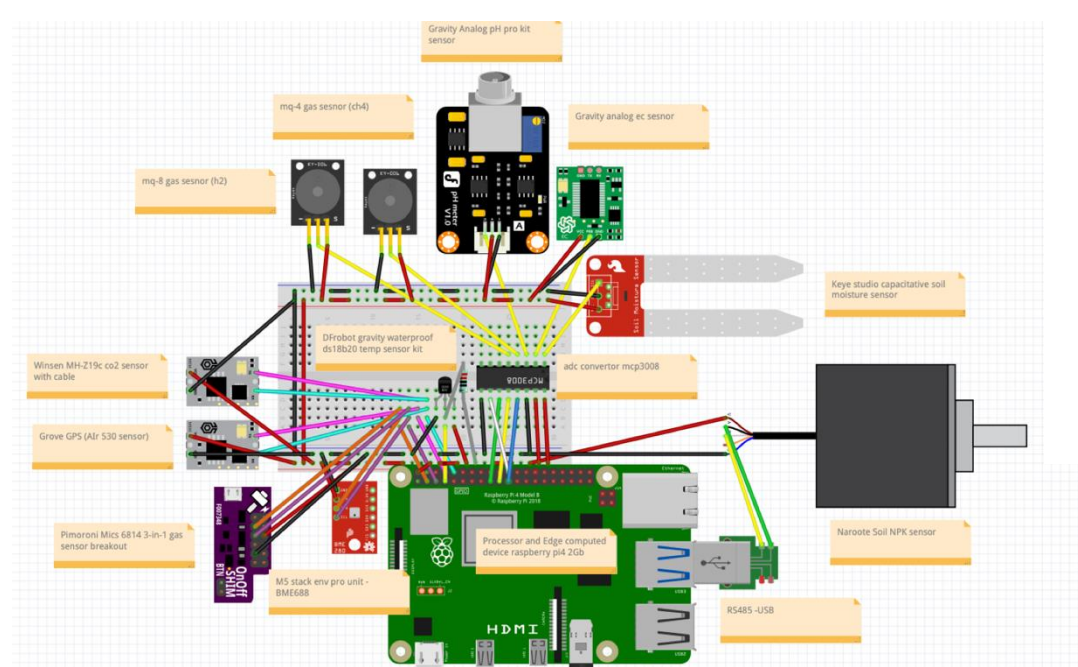


# Towards Digital Twins

## *Building a Networked Sensemaking System*

Digital Twins (DTs) for Biodesign are an important building block for measuring and understanding biological systems both in lab and field contexts from a data perspective. DTs can be understood (see Figure on the right) as combinations of different computational components, with specializations on different analytical purposes, from descriptive to predictive.

The distributed sensing system consists of sensor bundles that package 10 sensor modalities from temperature and humidity to pH and conductivity, to external data such as weather for a given location. The sensor bundles are soil-deployable and weather-resistant. They connect via IoT networking technology to a data collection hub.



All data will be organized and presented using a real-time dashboard interface that is map-based: it shows the exact locations of the IoT sensor bundles on the farm allowing for sense-making of soil properties by the farmer and connecting live data to the transition of soil and the farm.

Schematic adapted from: Vu, Đ. V., Funk, M., Huang, Y. C., & Barati, B. (2024). Addressing Uncertainty in Biodesign through Digital Twins: A Case of Biofabrication with Mycelium. *ACM Transactions on Computer-Human Interaction*, 31(6), 1-28.

