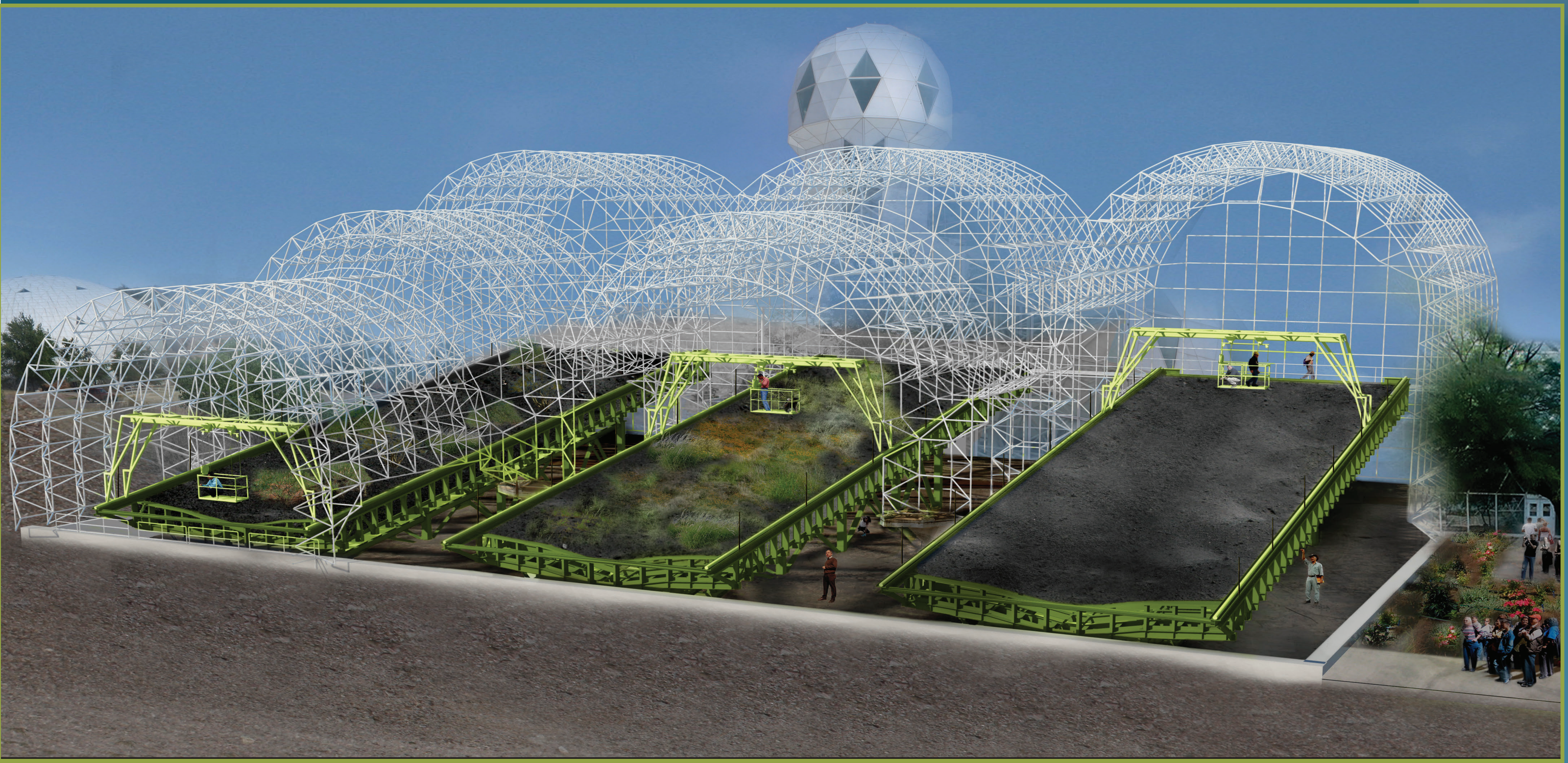
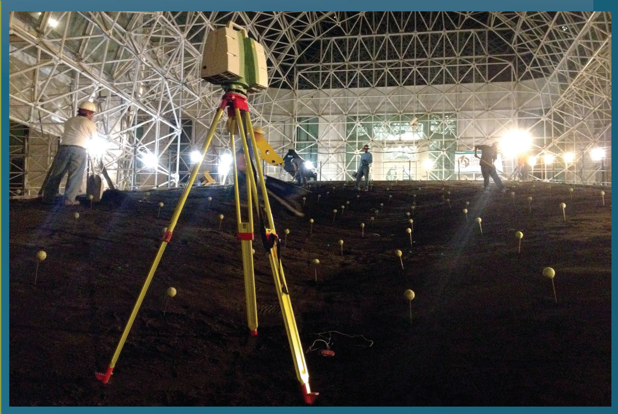
UA SCIENCE
THE UNIVERSITY OF ARIZONA.
COLLEGE OF SCIENCE

University of Arizona Biosphere 2

Landscape Evolution Observatory

LEO
Biosphere 2
Landscape Evolution Observatory





THE HILLS ARE ALIVE:

EARTH SURFACE DYNAMICS IN A CONTROLLED ENVIRONMENT

To meet the challenge of predicting landscape-scale changes in Earth system behavior, the University of Arizona has designed and constructed a new large-scale and community-oriented scientific facility – the Biosphere 2 Landscape Evolution Observatory (LEO). The primary scientific objectives are to quantify interactions among hydrologic partitioning, geochemical weathering, ecology, microbiology, atmospheric processes, and geomorphic change associated with incipient hillslope development. The infrastructure is designed to facilitate investigation of emergent structural heterogeneity that results from the coupling among Earth surface processes by rapidly iterating dense experimental measurement with development and validation of coupled computational models.

LEO consists of three identical, sloping, 333 m^2 convergent landscapes inside a 5,000 m^2 environmentally controlled facility. These engineered landscapes contain 1 meter depth of basaltic tephra ground to homogenous loamy sand that will undergo physical, chemical, and mineralogical changes over many years. Each landscape contains a spatially dense sensor and sampler network capable of resolving meter-scale lateral heterogeneity and sub-meter scale vertical heterogeneity in moisture, energy and carbon states and fluxes. The density of sensors and frequency at which they can be polled allows for measurement to be made that are impossible in natural field settings. Embedded solution and gas samplers allow for quantification of biogeochemical processes, and facilitate the use of chemical tracers at very dense spatial scales to study water movement. Each ~1000 metric ton landscape has load cells embedded into the structure to measure changes in total system mass with 0.05% full-scale repeatability (equivalent to less than 1 cm of precipitation). This facilitates the real time accounting of hydrological partitioning at the hillslope scale. Each hillslope has an engineered rain system capable of raining at rates between 3 and 45 mm/hr in a range of spatial patterns. The rain systems are capable of creating long-term steady state conditions or to run complex hyetograph simulations. The precipitation water supply storage system is flexibly designed in order to facilitate addition of tracers in constant or time-varying rates to any of the three hillslopes.

These landscapes are being studied in replicate as "bare soil" for an initial period of several years. During this time investigations will focus on hydrological processes, surface modification by rainsplash and overland flow, hillslope-scale fluid transit times, evolution of moisture state distribution, rates and patterns of geochemical weathering, emergent non-vascular and microbial ecology, and the development of carbon and energy cycles within the shallow subsurface. After this initial phase, heat- and drought-tolerant vascular plant communities will be introduced. Introduction of vascular plants is expected to change how water, carbon, and energy cycle through the landscapes, with potentially dramatic effects on co-evolution of the physical and biological systems.

LEO also provides a physical comparison to computer models that are designed to predict interactions among hydrological, geochemical, atmospheric, ecological and geomorphic processes in changing climates. These computer models will be improved by comparing their predictions to physical measurements made in LEO. The main focus of our iterative modeling and measurement To meet the challenge of predicting landscape-scale changes in Earth system behavior, the University of Arizona has designed and constructed a new large-scale and community-oriented scientific facility – the Biosphere 2 Landscape Evolution Observatory (LEO). The primary scientific objectives are to quantify interactions among hydrologic partitioning, geochemical weathering, ecology, microbiology, atmospheric processes, and geomorphic change associated with incipient hillslope development. The infrastructure is designed to facilitate investigation of emergent structural heterogeneity that results from the coupling among Earth surface processes by rapidly iterating dense experimental measurement with development and validation of coupled computational models. cycle is to use rapid data assimilation to facilitate validation of newly coupled open-source Earth systems models. Some of these models include the NOAH-MP land surface model, the CATHY hydrological model, and the PHREEQC geochemical model.

Technical Specifications

Scale:
11.25 m wide by 29.60 m long. Overall slopes are 10° with a max of 17°, providing 5.2 m of relief

Sensors in each (of three) landscapes:
496 Decagon 5TM soil water content
992 soil temperature sensors (Decagon 5TM and MPS2 thermistors)
496 Decagon MPS2 soil water potential sensors
496 soil Prenart Super Quartz water samplers
141 custom PTFE soil gas samplers
48 Vaisala CARBOCAP GMM220 Carbon dioxide concentration sensors
24 Hukseflux HPF-1 and HPF-1SC surface heat flux plates
120 custom electrical resistivity tomography probes
34 GeoInstruments VW 10 psi piezometers
10 semi-custom Honeywell load cells
15 mag flow and tipping bucket flow meters in rain and drainage system
1 3D laser scanner
A suite of permanent and deployable atmospheric and ecological instrumentation

Follow construction progress live on streaming webcams: leo.b2science.org

LEO will be a community resource for Earth system science research, education, and outreach

The LEO project operational philosophy includes:
1) open and real-time availability of sensor network data,
2) a framework for community collaboration and facility access
3) community-guided science planning and
4) development of novel education and outreach programs.

Find out more by going to leo.b2science.org

Biosphere 2
THE UNIVERSITY OF ARIZONA.