

ECOLOGY

Cash advance, new approach aim to relaunch Biosphere 2

By Erik Stokstad

Looking like a futuristic space ship that has landed in the desert, Biosphere 2 has always been an oddity. The early days of this massive, enclosed facility were marked by high-profile attempts to have people live inside a sealed ecosystem for up to 2 years. After that flopped Columbia University took over and conducted ambitious climate change experiments. But officials abruptly pulled the plug in 2003 after costs became unsustainable (Science, 19 December 2003, p. 2053).

Since 2007, the University of Arizona (UA) has managed a modest amount of research at the facility, primarily focusing on ecohydrology. Now the university, aided by two major gifts last week, is pushing ahead with plans to revive the scientific fortunes of Biosphere 2. On 1 July, the real estate development company that owned the 16-hectare campus donated it and the iconic building to UA. At the same time, financier — and longtime Biosphere patron — Edward Bass announced he would chip in \$20 million by October to support operations and research. “It’s on a good trajectory,” says plant biologist Joseph Berry of the Carnegie Institution for Science in Stanford California, who led the scientific advisory committee for Columbia.

The challenge will be for UA to attract enough research grants to make Biosphere 2 viable in the long term. University officials are betting big on a set of experimental hillslopes, which will eventually take up more than 25% of the facility. Much more space could ultimately be developed for other research into the impact of climate change on temperature and rainfall. “I am excited about the options for experiments in large, well-controlled replicated habitat,” says Chris Field head of the Carnegie Institution Department of Global Ecology.

Located 50 kilometers from Tucson, Biosphere 2 was built in the late 1980s for \$200 million by Space Biospheres Ventures. Funded primarily by Bass, the company aimed to develop technology for space colonization. The campus boasts 13,000 square meters of airtight greenhouses, a 3-megawatt power plant, dormitories, and a conference center. Biomes include an “ocean” with coral reef, mangroves, tropical rainforest, and savanna. Two high-profile experiments in the early 1990s, which sealed crews of “biospherians” inside the glass pyramids, encountered many problems, including falling oxygen levels.

In 1994, Bass’ investment company took over and brought in Columbia University to manage the site. Researchers spent 7 years revamping Biosphere 2 and investigating the effects of elevated carbon dioxide levels on ocean and terrestrial ecosystems. These experiments didn’t need the facility to remain airtight, but they required complex ventilation and air conditioning to control the atmosphere. After Columbia ended its contract, because of expense and an inability to win enough government grants, Bass sold the property and surrounding ranch to a real estate development company. The research equipment was auctioned off, and the site became just a tourist attraction. (Biosphere 2 is still a major draw; more than 100,000 people a year pay up to \$20 to visit.)

UA started up research again in 2007, and Bass has donated about \$4 million per year for salaries, repairs, and operations. The university hired nine scientists, led by plant ecologist Travis Huxman, to work at Biosphere 2. In a big change, they essentially opened the windows, shifting Biosphere 2 from a “partially closed” system, in which CO₂ concentration was manipu-



Gaining ground. Biosphere 2’s massive greenhouse will host a unique experiment in soil processes.

lated to “open flow” with external air. This saves roughly 75% in energy costs, and Huxman says it also allows for better measurement of water vapor. “To be honest, there are many facilities and sites in natural settings tackling the CO₂ question,” Huxman says. Since 2007, a number of small-scale experiments have taken place at Biosphere 2, including a study of the impact of temperature on pinyon pine mortality.

A more ambitious flagship effort is now gaining momentum. Called the Land cape Evolution Observatory (LEO), three large artificial hillslopes will be built in what was the 2000-square-meter farm biome. The first goal is to study how water flows through soil and alters its chemistry. Then researchers will investigate how vegetation impacts the interactions of carbon and water cycles under various climatic conditions. The first phase of the \$6 million construction, all of which has been funded by Bass, should be completed in January. Although this kind of research could be done in a traditional greenhouse, the scale of Biosphere 2 allows for large plants and “semi-realistic” ecosystem settings, says William Schlesinger, who directs the Cary Institute of Ecosystem Studies in Millbrook, New York.

The overall approach makes sense to plant biologist Barry Osmond of the Australian National University in Canberra, who led Biosphere 2 from 2001 to 2003. “It is a good move, securing long-term focus for a large number of really talented researchers to a unique experiment,” he says. “This seem a much more robust, more sustainable and achievable operating model” than Columbia’s attempt to quickly build a major research facility, like a national laboratory, and fund it with a large government contract.

Whether UA can truly revive Biosphere 2 as a scientific destination in the desert depends in part on whether its researchers can win enough grants. (So far they’ve been awarded more than \$624,000 from the U.S. National Science Foundation.) Joaquin Ruiz, dean of the UA College of Science, says the goal is to use the funding from Bass to get LEO running, then invest the remainder as a quasi-endowment to help cover operations. Salaries would be covered by grants and income from tourism.

The handover of Biosphere 2’s ownership, from CDO Ranching & Development to the university, should also help science. Researchers will have more flexibility to modify the buildings, if necessary. “It does offer some stability to a facility with an otherwise confusing past,” Schlesinger says. “Biosphere 2 is a big commitment on the part of UA.”