In most people’s minds, Biosphere 2 was a fabulously expensive failure, a $200 million earth-in-a-bottle that choked on carbon dioxide and was overrun by ants. But not everybody feels that way.

"In our view, Biosphere 2 was a tremendous success," said Bill Dempster, the project’s engineering systems director and designer of the sphere’s remarkable lungs. "Many people don’t realize that hundreds of papers were written about it."

Columbia University and the University of Arizona eventually took over the sphere, and its original inhabitants are largely remembered for personality conflicts, controversy and general New Age oddness. But they left some interesting science behind.

**Extraterrestrial settlement.** Before humanity can establish communities on other planets, it will have to figure out how to live there, most likely in self-sustaining artificial habitats. Those discussions, dating back to NASA physicist Gerard O’Neill’s deep-space cornucopias in the 1970s, fueled Biosphere 2’s conception. Dozens of papers discuss its technical lessons for future settlements. Among them: "The legacy of Biosphere 2 for the study of biospherics and closed ecological systems" and "Living in space: results from Biosphere 2’s initial closure, an early testbed for closed ecological..."
systems on Mars."

Closing the bubble. Though part of the above category, Biosphere 2’s seal system was so fantastic as to deserve its own heading. The unexpected rise in CO2 and fall in oxygen that jeopardized inhabitant health wouldn’t have been detected were it not for its near-total atmospheric containment.

"They did the best seal ever made of anything," said University of California, Santa Barbara naturalist Daniel Botkin, one of the sphere’s original advisors. Biosphere 2 leaked just 10 percent of its oxygen a year. The space shuttle leaks 2 percent a day. (See "Methods for measurement and control of leakage in CELSS and their application and performance in the Biosphere 2 facility" and "Oxygen loss in Biosphere 2.")

Atmospherics.
"It motivated a lot of research into oxygen dynamics and measurements of the pathways that the carbon cycle was going through," said Mark Nelson, one of the original B2 crew members. "In the global biosphere, despite all the research going into climate change, there is still missing carbon. Is it in the land? The ocean? In Biosphere 2, we could pinpoint exactly where carbon and oxygen resided." (Read more in "Self-organized Criticality in Closed Ecosystems: Carbon Dioxide Fluctuations in Biosphere 2" and "Simulation of community metabolism and atmospheric carbon dioxide and oxygen concentrations in Biosphere 2.")

Agriculture. According to Nelson, the agriculture system was arguably the most productive half-acre of land in farming history. Sure, they lost a lot of weight, and ate so little as to produce an early human study of caloric restriction, but they did survive for two years on a half-acre output. And contrary to most extraterrestrial-farming thinking, it used old-fashioned soil. "You need a soil that’s rich and uses compost," said Abigail Alling, a Biosphere 2 inhabitant and director of research. "You can’t do it on hydroponics alone. (See "Soil in the agricultural area of Biosphere 2" and "Crop yield and light/energy efficiency in a closed ecological system: two laboratory biosphere experiments.")

Bioremediation. The inhabitants’ wastewater was treated in Biosphere 2’s swamp biome, anticipating the contemporary trend of using artificial or resurrected wetlands to handle urban waste. (Read "Bioregenerative recycling of wastewater in Biosphere 2 using a constructed wetland: 2-year results"
and "Wetland systems for bioregenerative reclamation of wastewater: from closed systems to developing countries."

Finally there’s the cultural legacy, a general awareness of Earth itself as a largely-closed system that can be easily and unpredictably perturbed. It’s a useful lesson in a geological age referred to by scientists as the anthropocene. "Up until Biosphere 2, there had never been any biosphere in the known universe, except for Earth," said Dempster. After the project’s completion, "all of a sudden everybody was very conversant with the idea of a biosphere, and now it’s a common word."

"The humans became a very important part of Biosphere 2," said Alling. "It’s a very hopeful message. Even though the dynamics were a challenge, we loved our biosphere. If it was well, we were well."

*For a comprehensive list of Biosphere 2 papers, see bibliographies at the Institute of Techtonics and Biospheres.*

See Also:

- Home Developer Buys Biosphere 2
- Wired 12.12: 10 Lessons from Biosphere 2
- Life Inside the Biosphere Bubble
- Biosphere Crew Hawks Pets with Space Pedigree

Images: University of Arizona

Brandon Keim’s Twitter stream and Del.icio.us feed; Wired Science on Facebook.

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