Message from the Associate Dean

The University of Arizona College of Science is developing a comprehensive outreach plan to take advantage of the incredible opportunities afforded us through facilities such as Biosphere 2, the Flandrau Science Center, Tumamoc Hill, and the Mt. Lemmon SkyCenter. This effort will combine both our informal, public outreach activities with our more formal K-12 education outreach programs. We believe that by helping to coordinate and integrate our outreach efforts, we can have a significant, positive impact on our local community.

In the K-12 sector, we are developing a number of significant new programs. One example is a college-wide service learning program, where undergraduate and graduate students will work with middle- and high-school students to provide mentoring and tutoring opportunities. This program will also include sponsored trips to UA Science facilities such as Flandrau and Biosphere 2, where secondary school students will engage in fun, educational activities to further explore the role of science in their lives. These trips will also help acquaint students to the UA as a future destination, breaking down some of the barriers to higher education.

Another K-12 outreach effort is an initiative to create a community of educators, including K-12 teachers, UA staff and faculty. To build such a community, we are creating a number of new resources that will help each of these constituents to connect to each other. One such resource is a new website that has a searchable faculty/staff database that teachers can use to help find researchers engaged in activities such as classroom visits, lab tours, and public lectures. We are also offering a series of Teacher Science Cafes, where teachers can learn about science, interact with other teachers, and find out the latest offerings at the UA. We expect to expand upon these new initiatives to help build a broad and dynamic educator community. In addition to these formal education programs, we are beginning to integrate the public outreach efforts throughout the College of Science.

We are very excited about the possibilities afforded us by our new outreach activities. The new innovations and research within the UA College of Science will now be more readily shared with both the general public as well as our colleagues in the K-12 education system. We expect that this will have a very positive impact on the Tucson region, and will further enhance the very things that make Tucson a special place.

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New Grant Supports Study of Plant, Microbe Effects on Weathering

The National Science Foundation (NSF) recently awarded a three-year, $424,623 grant to University of Arizona researchers to investigate how plants and microbes influence mineral weathering and leaching of mineral-forming elements. This research will look at how tree and grass species common to the western United States (Ponderosa pine and Buffalo grass) affect bacterial and fungal communities (particularly mycorrhizal fungi) to promote the weathering of rock-derived minerals and the incipient formation of soil. Scientists will focus on interactions between biological and mineral components during laboratory-based weathering of four common rock types (basalt, granite, schist, and rhyolite) and the extent to which this weathering results in chemical loss versus biomass accumulation or re-precipitation of dissolution products.

The research team is led by Katerina Dontsova, an assistant research professor at Biosphere 2 Earthscience, and includes Travis Huxman, director of Biosphere 2 and professor of ecology and evolutionary biology, in addition to professors Jon...
Featured Research

Building Mountains in Biosphere 2: The Landscape Evolution Observatory

Even a short hike into the mountains of the Southwest can take you across hot, dry, rocky slopes covered with yucca, grass and cactus, while just around a bend in the trail, a change in exposure might reveal cooler, shady—perhaps even moist—slopes of juniper and oak. From Tucson, we just need to look upward to see that the mountain slopes also change dramatically with elevation – from open rocky desert at the base up to the cool, moist pine forest at the peaks. We understand intuitively that when it rains here, some areas generate runoff quickly and dry rapidly with the reappearance of the warm sun, while other areas stay cooler and damp through the rainy seasons. We see that our limited rainfall is used opportunistically by plants and animals; vegetation can change from day to day as the rains come and go. The brief periods of running water, wet ground and thick, green mesquite and palo verde trees give desert dwellers a sense of the dynamic nature of life in arid regions, and the importance of water above all else in our natural environment.

As our climate warms, what will be the fate of arid places here and everywhere that depend on local water sources, seasonal rains, and the success of local ecosystems and agriculture for survival? Do we fully understand how much-needed rains are distributed across landscapes, into the soil, plants, groundwater reservoirs, rivers and streams, and back to the atmosphere? Each of these systems is complicated enough when studied in isolation; understanding how all of these components of the water cycle work together requires new tools, new predictive models, and new teams of experts from a wide range of earth science disciplines.

With the goal of predicting how the terrestrial water cycle will respond to climate change, we have begun the largest structural change to Biosphere 2 since its original construction over 20 years ago. We are building three two-million-pound artificial landscapes inside the former agriculture biome. These huge physical models will allow us to tackle two significant scientific questions: How does rainwater interact with and change landscapes over time, and how does biological activity change landscapes over time? Both questions are tremendously complicated, and require unprecedented cooperation between scientists from a range of earth-science disciplines and development of new tools that permit detailed measurement of water, life and energy in a large-scale, highly controlled environment.

The three artificial watersheds will be known as the Biosphere 2 Landscape Evolution Observatory (LEO). The landscapes are intended to be physical models of “hillslopes.” What is a hillslope? If you are hiking to the upper reaches of a mountain canyon, you can continue upstream until the stream channel in which you are walking gets smaller until it no longer appears to be a channel at all. You have reached the channel head, but you are not yet at the top of the ridge above you. The unchanneled landscape above you is made up of hillslopes, not channels, and any rain that falls must either cross or move through (infiltrate) these hillslopes to get to the river channel. Depending on the climate, elevation, geology, and direction the slope is facing, the hillslope will have a certain type of soils, plants, and shape. Many different processes will occur on it during rain storms, such as interception by plants, runoff over the surface, infiltration into underlying soil, and erosion of tiny bits of soil. The large landscapes we are building in the LEO are

“This is the place, I said, that you would come if you wanted to know the truth about water”

—Craig Childs, in the Grand Canyon

Preliminary structural model of the Lansdcape Evolution Observatory watersheds.
designed to replicate a wide range of these processes. But, because we are building them from scratch, we will know the specific physical characteristics of each one in a way that we could never know in nature, and, even better, we can install a variety of measurement devices into and around the landscapes during construction that allow us to measure how water and energy move across and through them at a level of detail impossible in nature.

These 40-by-100-foot LEO landscapes will be steel structures that reach over two stories tall, covered in over three feet of engineered soil and shaped to approximate the form of hillslopes in nature. Thousands of sensors will be embedded in the soil to measure soil moisture, water availability, temperature, and soil energy fluxes; specially designed samplers will provide access to soil water and soil gas from hundreds of locations in the soil without any external disturbance. We will be able to control precipitation, temperature, humidity and atmospheric composition within LEO for precise experimentation. One of the most dramatic capabilities will be the ability to balance the entire water cycle budget in real time using a system of precise scales built into the steel structure. The scales will be able to measure changes in the total weight of the hillslope as water enters it as rain and leaves as soil-water flow, overland flow, evaporation, and transpiration by plants. This will require the ability to measure weight changes as small as five one-hundredths of a percent of the two-million-pound weight. Soil properties have been carefully selected so that within a period of years, we will see changes in the mineral composition of the soil due to chemical weathering that will lead to changes in how water moves through it. We plan to observe how this physical system evolves from its initial conditions, and then introduce plants to see how the establishment of ecosystems changes the physical and chemical systems of the soil that, by then, we will have been studying for 2-3 years.

Construction of this unprecedented facility is scheduled to begin by early 2011. Keeping with our mission of being a center for education, research, and outreach, the entire process from construction to operation will be highly visible to the public. Keep up on the latest progress by visiting our website, interactive media (twitter.com/B2science), and by visiting Biosphere 2 in person to see "big science" in action!

Biosphere 2 kicked off its first Research Experiences for Undergraduates (REU) program this past summer thanks to a $400,000 grant from the National Science Foundation. The program hosted 10 undergraduate students from several disciplines within earth and environmental sciences, who came from 8 different universities across the country (including one from the University of Arizona) to live at Biosphere 2 and work in research labs there and at the University of Arizona. Each student worked with a faculty mentor over the course of 10 weeks to design and implement a research project from start to finish. For many students, it was their first experience conducting field and lab research.

The students completed their summer with poster presentations at the University of Arizona Undergraduate Research Opportunities Consortium Conference. In addition, Cynthia Wright, who was mentored by Dr. Greg Barron-Gafford, presented her research at the Society for the Advancement of Chicano and Native Americans in Science conference in Anaheim, California, at the end of September, and her poster won the prize for best presentation in ecology. Many other students will present their research this fall at the American Geophysical Union’s annual conference.

The students’ response to their experience at B2 was overwhelmingly positive. One remarked, “After this REU experience, I feel that I have a major advantage over other students applying for grad school. I’ve been working in a lab at my university for the past year, but I have learned just as much, if not more, during the course of this ten-week program.”
Gift Supports Storm Water Research by Undergrads

A recent student research gift from the Paul Galvin Memorial Foundation Trust to Biosphere 2 will support the development of a monitoring and experiment program to better understand the chemistry of storm-water run-off, its impacts on ecosystems, and its potential application in water harvesting and irrigation of landscaping and gardening. The program will be run under the direction of Dr. Mitchell Pavao-Zuckerman, Assistant Research Professor with B2, and will fund exclusively undergraduate student-directed research projects. The research program will interface with existing student support (e.g., through programs such as the National Science Foundation-supported B2 Research Experiences for Undergraduates Program, and the UA Undergraduate Biology Research Program) and also support the offering of directed research hours for credit and opportunities for honors thesis projects through the students’ home departments at UA. The Storm Water Application and Monitoring Program (SWAAMP) will extend B2’s outreach missions by providing information for Pima County and City of Tucson environmental managers and local stakeholders who are currently developing storm-water best management practices (BMPs) and regulations.

As arid cities such as Tucson grow in size, their demand for water resources increases greatly. One strategy to meet this need is to reconnect hydrologic flows in cities to capture rain-water and storm-water runoff through various water-harvesting approaches. Using storm water for irrigation and gardening presents challenges because of the potential for pollutants from the urban environment to enter and concentrate in ecosystems. The flashiness of rain events in Tucson exacerbates this issue, as roads can sit for weeks or months accumulating pollutants before storms wash them into areas selected or designed to capture runoff for use. Thus, understanding the potential benefits and risks in using storm water for domestic and commercial irrigation purposes is an important application of ecohydrology research towards urban sustainability. The major questions addressed by the SWAAMP program include: (1) what are nitrate and heavy-metal loads to BMPs already in place in Tucson (curb-cuts, rain gardens, swales); (2) how do these chemical loadings impact normal ecosystem functions relating to nutrient cycling and plant growth; and (3) if storm-water runoff is used to grow plants, will it impact plant health or potentially transfer dangerous chemicals to people?

Third Annual Amazon-PIRE Field Course Held in Brazil

From June 27 to July 9, Amazon-PIRE (Partnership for International Research and Education) held its third annual international field course on tropical forest dynamics and biogeochemistry in collaboration with the Instituto Nacional de Pesquisas da Amazônia (INPA) in Manaus, Brazil (http://lba.inpa.gov.br/lba). The course took place at three research sites near Manaus in the Amazon basin: the Alfonso Ducke Reserve, the Cuíiras Reserve (site of the longest continually operating eddy flux tower in the Amazon), and the Biological Dynamics of Forest Fragments Project (BDFFP), a 1000 km2 landscape of primary rainforest, forest fragments, and a matrix of grassland and regenerating forest, that is the site of the world’s longest-running experimental study of habitat fragmentation.

With the overall motivating question, What is the future of Amazon forests under climate change?, the primary theme for the 2010 summer field course and field projects was “Understanding the Amazonian mosaic: from plateaus to valleys, from primary to secondary forests.”

Seventeen instructors from universities and government agencies in Brazil, as well as instructors from the University of Arizona and Harvard University, met with 22 students from the U.S. and Brazil to focus on the effect of topography on forest dynamics and interactions with the atmosphere.

Amazon-PIRE, directed by ecology and evolutionary biology assistant professor and Biosphere 2 science steering committee member Scott Saleska, is a partnership between the U.S. and Brazil. U.S. funding is provided by the National Science Foundation’s Office of International Science and Engineering. Brazilian support comes from INPA through the Large Scale Biosphere Atmosphere Experiment in Amazônia (LBA), and via individual collaborative projects funded by CNPq, of the Brazilian Ministry of Science and Technology.

For more information about Amazon-PIRE, see www.amazonpire.org.
Bigger IS Better: New SkyCenter Telescope Benefits Visitors

Sunrise on Monday, Sept. 13 found Steward Observatory Mountain Operations, RC Optical Systems and Mt. Lemmon SkyCenter staff installing the largest telescope dedicated to public observing in the Southwest: the 32-inch Schulman telescope. Several long days and nights of dedicated effort were needed to assemble the over 5,000-pound, 12-foot-tall instrument, set up the control system, and establish connections to the main observatory. But the team’s efforts paid off: the observatory was up and running in time for Adam Block’s Saturday night SkyNights program on Sept. 18, when guests saw Jupiter’s Great Red Spot, nebulae and star clusters through the new instrument.

This telescope is more of a custom-made than an assembly-line product. These types of telescopes usually take about 18-24 months to design, build and install to the specifications of the operator/owner. For SkyCenter use, the instrument must be safe and easy to use for public programs while being able to deliver digital images of exceptional quality. Over the next few weeks, the Mountain Ops and SkyCenter staff will take the telescope through a series of detailed tasks to determine if it meets all specifications and requirements. The improved precision of the drives and larger aperture of the 32-inch Schulman telescope will go far to maintain the SkyCenter’s preeminence in public outreach programs. Under the guidance of Adam Block, SkyCenter’s primary presenter and astrophotographer, the SkyCenter has already achieved worldwide recognition for its images: pictures generated by visitors have been published in magazines, books and on websites. Program participants who peer through the new telescope will see brighter-looking stars and better contrast in deep-space objects compared to those seen through smaller telescopes.

Eventually the 32-inch Schulman telescope will operate with both on-site and remote operators, dramatically increasing the access of the public and serious amateurs to this equipment. SkyCenter has remote-feed capability via Internet at present and will continue to promote collaborative programs with Biosphere 2, Flandrau Science Center, and other venues, giving those not on the summit a taste of mountaintop observing to whet their appetites for the on-site observing at Tucson’s highest destination.

Acquisition of the 32-inch Schulman telescope was made possible through the Joe and Dixie Schulman Foundation along with a generous donation from Richard Caris. Mr. Schulman has been a committed advocate and supporter of SkyCenter’s mission and his donation makes possible the centerpiece of the summit educational programs.

Along with established SkyNights, SkyTours and AstronomerNights programs, SkyCenter’s public observing program offers special programs, such as the popular Our Place in the Universe, and programs with a focus on special events such as the Geminids meteor shower on Dec. 13 and the winter solstice and total lunar eclipse on Dec. 21. SkyCenter is also highlighting NASA’s Year of the Solar System by tying into many NASA themes and mission events.

50 Years of Laser Innovation at Flandrau Science Center

This fall semester, visitors have the rare opportunity to explore the history of the laser and the physics behind this amazing and versatile technology in Flandrau Science Center’s expansive exhibits hall. The story of the laser is presented in Laserfest, a unique display created by the International Society for Optical Engineering (SPIE), that features over 130 lasers and backdrops describing their history and many applications. Lectures and interactive floor demonstrations give the public an opportunity to learn from experts how lasers play a significant role in the science being done at the University of Arizona in fields as diverse as optical sciences, medicine, molecular and cellular biology, and astronomy.

“The Flandrau exhibits and events don’t merely demonstrate how curiosity-driven science can lead to profound and transformational changes,” said Dr. Pierre Meystre, Regents’ Professor of Physics and Optical Sciences. “They also highlight the central role played by Arizona and Tucson in these developments, with many of the central players, including Nobel laureates Nicolaas Bloembergen and Willis Lamb, laser pioneers Peter Franken, Marlan Scully, Stephen Jacobs, and many others having chosen to make Tucson and The University of Arizona their home.”
AZ Center for STEM Teachers Summer Institute Generates Enthusiasm

Arizona Center for STEM Teachers (ACST) completed its second summer institute this past June at Biosphere 2. From June 18 – July 2, 50 kindergarten through third grade teachers from all over Arizona lived in residence at the facility, engaged in “under-the-glass” hands-on science research, and participated in numerous content sessions designed to motivate them and improve their science teaching. The whole experience, including a stipend and laptop computer, was provided to the participants at no cost.

“Being immersed in science at Biosphere 2 helped me build a love for science and fostered how important teaching science to our students is. Now with everything I do, I am able to make a connection to science, and I want to inspire that thinking in my students. Science in my classroom this year has dramatically improved,” said Sara Pearson, a third-grade teacher at Washington Elementary School in Phoenix. “The students are engaged in science, using critical thinking and building that love that I have built. What an amazing experience I had the opportunity to be involved in! What I learned in the time I spent at the Biosphere 2 will have an everlasting change in the way I teach science.”

ACST was created in December 2008 through a three-year, $1.5 million grant by Science Foundation Arizona (SFAz) to The University of Arizona’s B2 Institute to establish a resource and training center that will expand the quality and retention of science, technology, engineering and mathematics (STEM) teachers in Arizona. The Philecology Foundation is partnering and providing a matching grant to fully fund the Center. The Center’s mission is to enhance and deepen the skills of Arizona STEM educators to ensure that their teaching translates to successful high-school graduates who can effectively compete and prosper in the 21st century marketplace.

“The B2 summer institute was the first workshop that I have attended in 17 years of teaching where I really felt like I was treated like a professional and being a teacher mattered. Science time in my classroom this year is a special event. I’m not as rigid with my science instruction and feel like I am giving my students a better science experience using inquiry. Instead of strict teacher-driven lessons (information presentations), I am letting my students explore and discover how things work by using their natural curiosity,” said Dorothy Wilson, a second-grade teacher at Lynn Urquides Elementary School in Tucson. “Our classroom zoo is proof of that this year. They are so interested in insects, all of them, and how they live, eat, act, etc. that we now have a praying mantis (caught by a student’s mom), various grasshoppers (caught by students), and a replenished milkweed bug population (caught again by students). Their insect interest has spawned an interest in all living creatures, so our zoo has expanded now to 2 hamsters and possibly a frog (of course, caught by a student). Instead of just learning science this year, I feel we are doing science.”

ACST is teacher-driven and provides Arizona STEM teachers with:

- intensive summer programs incorporating research projects, formal lectures and curriculum development;
- themed weekend coursework for building STEM education content and hands-on classroom curriculum;
- in partnership with the Arizona K-12 Center, professional coaching, mentoring and ongoing classroom support provided by experienced, master-level math and science teachers;
- a STEM teacher website and portal with online resources, toolkits, discussion boards and forums for sharing best practices, professional development and mentoring opportunities;
- broad-based linking partnerships for educators to access state-of-the-art teacher resources through the UA College of Science, the B2 Institute and B2 Earthscience, and other educational entities.

An essential feature of the Center’s programs is the role played by veteran teachers in developing and enabling statewide teacher professional development, and the universal support of faculty from all three Arizona universities needed to bring about systemic change. ACST will engage more than 300 teachers statewide within three years.

Michele Boone, a first-grade teacher at Hualapai Elementary School in Kingman was especially motivated to attend the summer institute. “I came to Biosphere 2 looking for new ways to integrate science and math together in my classroom using exploration and inquiry more often. I am looking at science and math in a whole new way. These students are our future scientists. Maybe their “Big Idea” will be something amazing and will have a significant impact on our lives.”

New Exhibit Displays the Art of Science

Biosphere 2 recently unveiled its newest exhibit, “Creativity and Consilience,” a compelling display of art and literature created by University of Arizona students inspired by conservation and environmental topics.

“Among our missions here is to increase the public’s scientific literacy and catalyze interdisciplinary thinking and understanding about Earth and its future” said Matt Adamson, Biosphere 2’s education and outreach coordinator. “Having these unique and, in some cases, quite beautiful pieces on display for people to look at and appreciate is really just another way we hope to get people thinking about science, conservation and the environment.”

The art is produced by students who take Dr. Kevin Bonine’s Environmental Biology and Conservation Biology courses at the University of Arizona. “In two of my courses, I assign a creativity project. The goal of the project is to foster the talents of students in non-traditional ways such that students internalize and recall more deeply the major lessons and themes of each course. Tapping into students’ creativity also allows for increased connections between the course material and different spheres and experiences personal to each student,” said Bonine, adjunct assistant professor in the UA’s Department of Ecology and Evolutionary Biology. “If we are to be successful in alerting the public to the challenges and risks inherent in environmental degradation and loss of biodiversity, then we must promote alternative modes of communication.”

The exhibit will rotate pieces through annually to remain fresh and current. “New art work will come to us every fall from Kevin’s classes, so return visitors to Biosphere 2 can expect to see changes to the exhibit over time for as long as we have the display in place,” said Adamson.

As the first significant student-produced exhibit to be displayed during the UA’s tenure at Biosphere 2, “Creativity and Consilience” gives Bonine great pride. “Over the years it has been my pleasure to work with talented individuals who have opened their minds and hearts to create fantastic and moving works of literature, sculpture, painting, photography and myriad other artistic pieces. To have some of these works on display at Biosphere 2 for thousands of people to see is very exciting.”

Earth Day 2010: The Now Generation Festival!

The University of Arizona Biosphere 2 held its second annual Earth Day 2010: Now Generation Festival on April 4, 2010. Attended by more than 1,500 people, this year’s theme, “The Now Generation,” was intended to reflect the ideals of the younger generation—the ones who will inherit and care for the Earth. The purpose of this event was to mobilize and enlighten the community by bringing the public together with artists, scientists, and students to view the environment in new ways through the scope of Biosphere 2. Science and art activities, tours, exhibits, live music and the unveiling of the B2 Solar Test Bed are just a sampling of the exciting activities that were offered during this day of fun and learning.
Grant, cont. from page 1

Chorover and Raina Maier in the Department of Soil, Water and Environmental Science, and Julia Perdrial, a researcher in the same department. “Assembling this strong interdisciplinary team allows us to address the challenging question of how plants and microorganisms work together to mine nutrients from rock during the formation of soil,” said Katerina Dontsova.

This project was funded through the “Emerging topics in Biogeochemistry” program at NSF that specifically focuses on research that transcends earth and biological science directorates. Travis Huxman notes that the “Biosphere 2 is ideally suited to serve as a center for this work because of its focus on interdisciplinary research that addresses Earth system processes.” This new project will closely integrate with related interdisciplinary projects at the UA, including the UA-led Jemez River Basin—Santa Catalina Mountains Critical Zone Observatory, the UA Superfund Research Program, the Biosphere 2 Landscape Evolution Observatory, and a grass mortality study, soon to be featured by National Geographic.

How You Can Help

Biosphere 2’s cutting-edge work depends on people who care about our environment and the science that helps us make informed choices. We hope you will consider becoming involved in any of the following ways.

1. Learn more about the many research projects taking place under the dome. You can see some of our ongoing research through our live webcam.

2. Take a tour of Biosphere 2. We are open every day from 9:00 to 4:00 except Thanksgiving and Christmas. Tours last approximately one hour and take you through the human habitat area where Biospherians lived and through each of the biomes. You will also have a chance to meet and talk with research scientists working onsite.

3. Become a member. There are many different levels of membership that provide benefits for you and support our work.

4. Attend a Science Saturday for a hands-on experience in science! Learn about bird species in the Southwest through an on-site birding tour, gain a new appreciation for insects and handle live ones, or participate in physics activities and demonstrations that show how water moves through urban environments.

5. Make a donation. Any gift is appreciated and can be designated to the Biosphere 2 activity or research project that matters most to you.

For more information on any of the above, visit our website: www.B2science.org.


Sustainability Tip

Without the presence of many animal decomposers found in a natural environment, B2 especially relies on fungus to keep plant waste from piling up inside. Now scientists are using similar fungus to break down the oil spilled in the Gulf of Mexico. You help put fungus to work in your own back yard by composting, and reduce the amount of waste that you send to the landfill.