ENVIRONMENT

Residents of this Brazilian neighborhood illegally tap power lines to access free electricity.
Photo by World Resources Council / Jonathan Talbot.

Sustainable Architecture

by Sandy Brown

The increased frequency and intensity of social, ecological and financial crises underscore a complex set of challenges facing the modern global system. Environmental degradation and climate change have called into question models of industrial development that rely on deforestation, non-renewable resource extraction and increasing carbon emissions to fuel growth. For much of the world's population, water stress, loss of livelihoods and social and cultural upheaval have become hallmarks of everyday life. These challenges have caused policy makers, financial institutions and civil society actors to increasingly turn their attention towards sustainability.

Such complex socio-ecological problems are at the forefront of Paz Gutierrez's research on sustainable technology innovation. For Gutierrez, a professor of Architecture at UC Berkeley, the critical question is one of "repositioning ourselves" with respect to resources in order to sustain the world's population and ecosystems. She argues for a fundamental shift in the way in which materials are conceived and utilized in the making of the built environment.

In her CLAS talk, Gutierrez laid out an approach to architectural research and practice that contrasts strikingly with traditional architectural thought, which "tends to think in terms of designing things as independent entities." She used the term "resourcing resources" to characterize this broad-based and interdisciplinary approach to sustainable building technology. The scale and scope of today's socio-ecological pressures require a rethinking of the relationship between the organic and inorganic world. In essence, she argued that architectural design must "work with nature" and not attempt to resist the natural world.

Nowhere have the negative consequences of industrial development been felt more acutely than in the developing world. In order to visually depict the uneven geographical distribution of socio-ecological vulnerability, Gutierrez presented a series of maps showing projected increases

in water stress, biodiversity loss and energy demand. By 2030, developing countries will use five times the energy of the developed world, the vast majority of which could come from non-renewable resources if alternatives are not actively sought. By the same year, 70 percent of the world's population will likely be affected by water stress, with the most extreme cases occurring in developing regions.

Gutierrez's current work focuses on the developing world, in particular Latin America. Her own experience growing up travelling between South America and Europe has shaped her thinking, not only about environmental issues but also about the unequal social and cultural contexts in which sustainability challenges unfold. Moving between different worlds caused her to think about the contrasts between the "bounty of the living world" and the everyday "struggles to access resources that occur in marginalized spaces."

While working for a corporate firm in the United States, Gutierrez suffered a crisis of confidence. Concerned about the inaccessibility of sustainable design innovation at the community level, she resigned her position. Fortunately, she was hired on as a consultant by the same firm. This allowed her to focus on using "high-end" technologies for community-based projects and to pursue broader approaches to sustainable innovation. This position has also allowed her to pursue academic research and teaching, most recently at UC Berkeley, where she established a research group comprised of architects, scientists and engineers, called Bioms, or Bio Input Onto Material Systems.

Addressing the problems of increasing population, diminishing land access and higher energy consumption requires interaction across academic disciplines. Taking such a collaborative approach has placed Gutierrez at the cutting edge of sustainable architecture. Under her leadership, the Bioms project recently landed a $2 million National Science Foundation grant for research on sustainable building technologies for developing regions.

The Bioms group is developing prototypes for thermal energy management, gray-water reuse and waste recycling, among other innovations. The project operates according to

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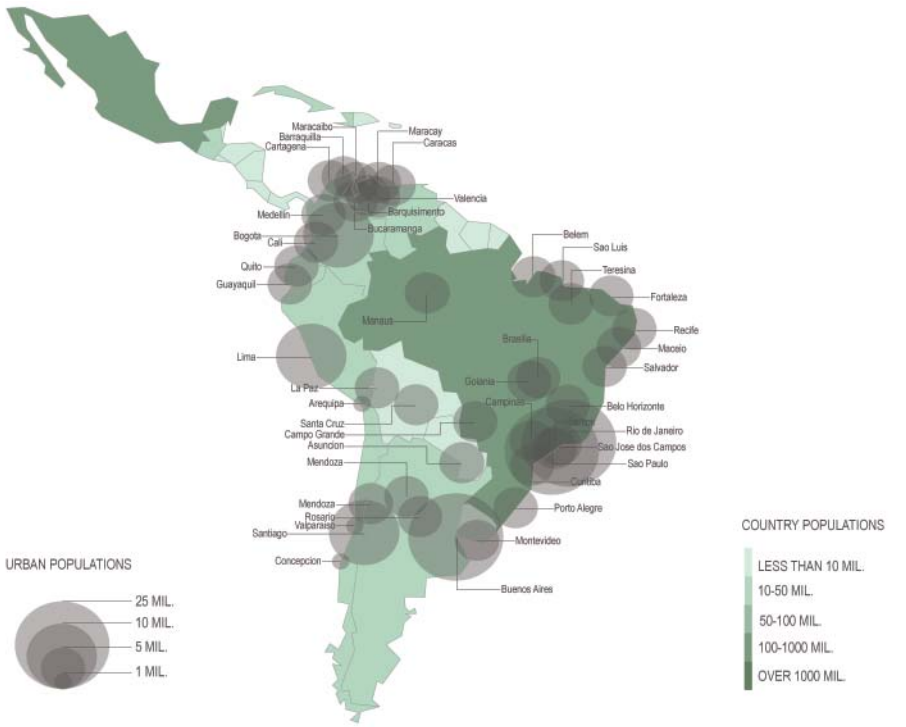
The School of Architecture at Chile's Universidad Andrés Bello, one of Gutierrez's early collaborations with the firm Murtinho Arquitectos.

Photo courtesy of Paz Gutierrez / Murtinho Arquitectos Asociados.



Many of South America's densest urban areas are coastal and vulnerable to flooding.
(Image courtesy of Paz Gutierrez. Data from the U.S. Census Bureau International Database.)

three fundamental principles. First, all stakeholders must be brought to the design table at the earliest stages of project development. Second, project materials must be adapted to their environment. Third, design problems must be addressed at multiple scales, from the geologic to the nano.

Responding to the social, cultural and physical factors associated with environmental pressures is central to the goals of Bioms. According to Gutierrez, in considering ideas for prototype development, she "always chooses worst-case scenarios." The Andean Altiplano, with its combination of extreme water stress, abundance of sun and cold nighttime temperatures, provides a case in point. For this region, Bioms is working on a project that utilizes solar power to disinfect gray-water for use in floor heating systems.

During her talk, Gutierrez discussed three projects in detail, all of which focus on employing material bio-responsiveness to address socio-ecological problems. The first project is engaged in creating deployable housing for flood-prone regions. In Latin America, many of the areas at high risk for flooding are heavily populated. Poor infrastructure and poor resource-management practices often exacerbate flood problems in these regions. Gutierrez and her research team are working to design structures that can be shipped and set up easily in times of crisis. In order to combine the advantages of a tent (i.e., lightweight and breathable) and a pneumatic structure (i.e., durable for the long term), they searched for materials that could be used for cooling and dehumidifying purposes in hot, humid climates.

Here, as in all of her work, Gutierrez looked to nature for models of efficiency to incorporate into her architectural design. In nature, insects are among the best equipped to identify comfort zones in places where high temperatures meet standing water, as in flooded areas. The team thus developed a dehumidification membrane that incorporates micro-lenses based on insects' eyes to detect natural light. The micro-lenses allow team members to create pores in the material that open and close depending on heat and humidity levels. They hope to have the prototype field tested and ready to be deployed within three years.

The second project looks to integrate agricultural surpluses and the reduction of plastic waste into the creation of building materials. Research has focused on the development of a sugar-based polymer that can achieve a level of transparency and refraction equivalent to that of glass. The goal is to create materials that are biodegradable and have the potential for less energy-intensive production. The project exemplifies the kind of "re-thinking of material resources to capitalize on the flows of nature" that Gutierrez called for in her introductory remarks.

Researchers on this project have also taken into account the role that agricultural commodity subsidies play in the global economy and the environmental effects of these agro-industries. Heavily subsidized commodities such as corn and sugar are increasingly being used for ethanol, with significant environmental and social implications. The project is working with sugar because sugar ethanol involves lower carbon emissions than its corn-based counterpart. Gutierrez noted that, while water use remains a concern in sugar production and processing, it still has significant advantages. The project team hopes to harness the potential of this alternative fuel technology to develop wall systems that are opaque on one side and transparent on the other, with the ability to refract light and control thermal conductivity.

A final project attempts to simultaneously address development issues and shoreline inundation, using salt water as an "asset for energy efficiency." There are two types of shoreline ecologies vulnerable to inundation — salt marshes in temperate climates and mangroves in tropical zones. Rising sea levels have increased the risk of flooding, particularly for those who rely on coastal ecosystems for their livelihoods, such as fishing communities. Such communities are also among the most susceptible to development pressures, as on the Chilean coast where the project is focused.

In this case, rising marine water could potentially be diverted into salt ponds, where it could be desalinated using solar energy. Such technology could serve the dual goals of increasing freshwater supply and energy production to power high-density development. Of course, the downsides to desalination remain a concern, given the production of contaminants and the potential to harm ecosystems that it entails. Nevertheless, Gutierrez argued that it is important to work towards developing technologies that will, over time, significantly reduce our dependence on non-renewable resources.

Gutierrez concluded by underscoring the importance of community involvement in sustainable technology design. Architects must be aware of the social and cultural conditions in which they work, conditions that are largely forgotten when working at the "high-end" of sustainability innovation. When asked to elaborate on the project's engagement with communities, Gutierrez noted that this component of the project is still being developed. In the coming year, she plans to spend several months working with communities in Latin America to evaluate how efforts in the lab connect with on-the-ground realities. Gutierrez noted that her past experience working in the United States had provided a valuable lesson in the critical importance of community involvement. In a fight with the Philadelphia School District over the use of experimental sugar-based materials for floor construction, community support tipped the scales in favor of approval for the project. Gutierrez hopes that her work in Latin America will engender the same level of support.

Paz Gutierrez is a professor of Architecture in the College of Environmental Design and the founder of the Bioms research group. She spoke for CLAS on November 8, 2010.

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A schematic of Gutierrez's temporary housing, designed for buoyancy, durability and regulation of its internal environment.

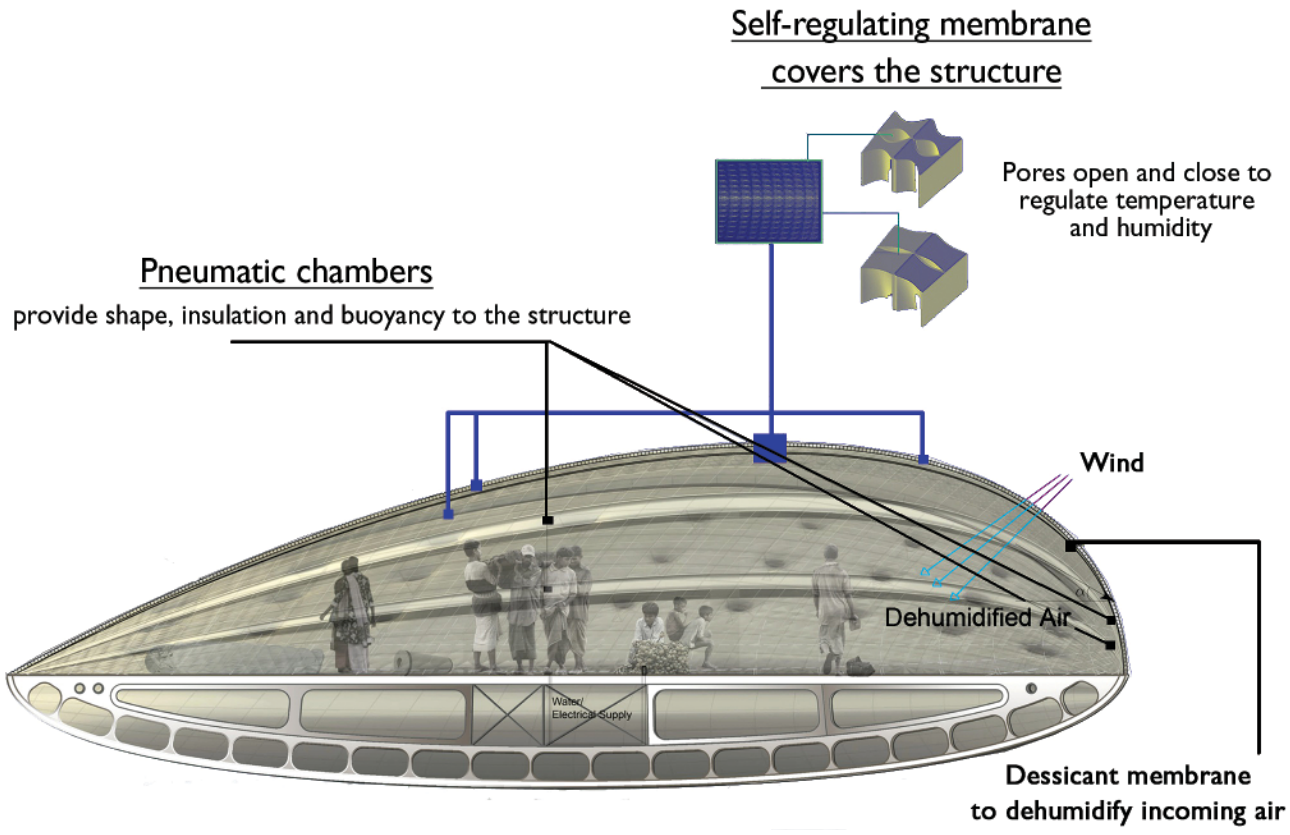

Image courtesy of Paz Gutierrez.