Where economy meets ecology

May 6 2014, by Leda Zimmerman

MIT professor John E. Fernández works at the forefront of urban sustainability, an emerging field that explores a city's economy and ecology. Credit: Len Rubenstein

Think of a city as a complex organism powered by human activities and consumption. John E. Fernández, an associate professor in the Department of Architecture, wants to understand how the urban metabolism works—what it needs in terms of energy, materials, and water to sustain the work and lives of its residents, and what gets discarded as waste. "When we speak of a healthy city," Fernández says,

"we are really focusing on whether it strikes a balance between economic growth and resource efficiency."

Fernández is at the forefront of an emerging science of urban sustainability that explores the interplay between a city's economy, increasingly tied into global networks, and its ecological consequences. With 3.5 billion people living in cities today, another 3 billion on the way, and the onset of climate change, urban designers are looking for successful models to accommodate humane and sustainable growth. Director of MIT's Building Technology Program and leader of the Urban Metabolism Group, Fernández has been immersed in several ventures that may bring such models closer to reality, by providing a framework for analyzing and enhancing urban sustainability.

One initiative identifies the types and volume of resources consumed in urban environments. "A city acquires and transforms diverse resources for its own metabolism," Fernández says. "We literally do a physical accounting of materials and energy required by an urban economy." This means measuring the millions of gallons of water used for drinking, power, and waste; kilocalories of fossil and other fuels consumed by residents, construction, and other industries; and tonnage of raw materials and goods entering a city. It also means calculating end products of human activity, such as wastewater and carbon dioxide emissions. So far, Fernández has conducted urban metabolism assessments of cities across the world.

"In the first century B.C.E., the Roman engineer Vitruvius laid out cities to take advantage of healthy wind flow, and he had it right to emphasize the relationship between the form of the city and its immediate environment," Fernández says. A couple of millennia later, the Urban Metabolism Group has produced an online tool to visualize the relationship between city form and resource consumption in 40 U.S. cities. The tool, urbmet.org, analyzes data to give users a picture of

resource and energy intensity at scales that vary from entire metro areas to specific neighborhoods.

Fernández notes that differences in resource usage among cities can be attributed to historical and technological factors, income and other measures of affluence, climate and location, and population size and density. Yet in spite of great variations among cities, all urban economies provide housing for people and firms, transportation, and critical goods and services. After examining similarities and differences among dozens of cities, Fernández and his students have developed a global urban typology based on resource consumption. With an analysis measuring per capita material impact and socioeconomic characteristics, they have defined eight city types, revealing some provocative groupings. Moscow, Santiago, Seoul, and Honolulu, which share medium-sized populations, city densities, and trade levels, fall into one group. Anchorage, Stockholm, and Abu Dhabi, dependent on oil production and intense consumers of resources, define another cluster. The Japanese cities studied constitute a group all their own, with low energy and biomass use, large populations, and small geographic areas.

Fernández hopes his research will help urban planners seeking methods for lowering resource consumption and accommodating growth. One possibility for cities to capture enormous energy savings, Fernández says, involves developing walkable districts of much greater population density in super-tall, high-performance buildings. "Civic life can move up," he suggests. "The global race to find pathways to urban sustainability has begun, and I hope to provide cities with the solid scientific foundation for understanding how to design and manage these transitions."

Provided by Massachusetts Institute of Technology